UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Development of a Total Quality Management tool integrating sustainability practices to address food waste: A case in a University food service unit

Boineelo Pearl Lefadola (13275004)
PhD in Consumer Science (Food Management)

2021

Development of a Total Quality Management tool integrating sustainability practices to address food waste: A case in a University food service unit

By

Boineelo Pearl Lefadola
(13275004)

Submitted in partial fulfilment of the requirements for the degree
PhD in Consumer Science (Food Management)

In the Faculty of Natural and Agricultural Sciences
University of Pretoria

Supervisor: Dr A.T. Viljoen
Co-supervisor: Prof G.E. du Rand

2021

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

DECLARATION

I, **Boineelo Pearl Lefadola** declare that the thesis, which I hereby submit for the degree PhD Consumer Science (Food Management) at the University of Pretoria, has not previously been submitted at this or any other tertiary institution, that this is my own work in design and execution and that all reference materials in the thesis have been duly acknowledged.

B.P. Lefadola .... 6 September 2021 ....

Boineelo Pearl Lefadola Date

DEDICATION

This thesis is dedicated to my late youngest sister **Faith Lone Nkele**, whom I lost on the 30^{th} of September 2020 during the process of my thesis writing.

Your voice of encouragement, the desire to see me complete my PhD and the strong belief you had in my capability kept me going.

May your soul continue to rest in peace.

ACKNOWLEDGEMENTS

First and foremost, I would like to praise and thank God, the Almighty, who has granted me countless blessings, knowledge, and the opportunity to undertake this PhD. You have been my helper and my strength.

I am extremely grateful to my supervisors, **Dr Annemarie Viljoen** and **Prof Gerrie du Rand** for their invaluable advice, academic stimulus, continuous support, and patience during my PhD study. Their immense knowledge and experience, meticulousness and rigour have transformed me into the academic researcher I am today. The completion of this thesis would have not been possible without the assistance of the Research Consultant in the Department of Statistics, University of Pretoria; **Joyce Jordaan**, who patiently assisted with the statistical analysis. I would like to express my deepest appreciation to **all research participants** at the University of Pretoria residential food service units, and the Delphi expert panel for the knowledge and experiences shared. Mr **Peter Martin**, I thank you for allowing me to access the residential food service units. I am indebted to **Etresia vd Westhuizen** who assisted with some of the documents used for the document analysis part of the data collection. Many thanks to the Food Services Operations Managers; **Marmara DeKlerk, Nomini Mamahlodi** and **Daniele Coetzee** for facilitating the data collection process at the food service units and for the support and courage given. I greatly appreciate **Ingrid Booysen** for the technical editing of my thesis, and **Prof Jane Spowart** for language editing.

I am indebted to the University of Botswana, for the scholarship provided to undertake my PhD. Had it not been for this financial support and time given away from work to focus on the study, this PhD could have remained a dream. My sincere gratitude to **Mrs Mokane** and **Ms Neo Seroke**, from the University of Botswana Staff Development and Training Office for assisting with all the financial arrangements to support my study.

My sincere gratitude goes to my family, my **husband**, my **twin boys** and my **daughter** for allowing me time off family duties, for your understanding and support throughout this difficult journey. In the process of completing my PhD numerous family outings, child developmental stages and celebrations were missed, and I am thankful for your sacrifices and understanding. My daughter **Fikile**, thank you for always listening to me talking about my thesis, comforting me, reminding me of deadlines and making sure I was emotionally well kept and sane throughout the process. My special thanks go to my sisters **Goitseone** and **Gorata**, for the consistent motivation and assistance with proofreading. Reminding me how capable I was, kept me writing when I wanted to give up. I would like to thank **my mum**, **Mrs Lenah Nkele**, for her prayers and words of wisdom. In the pursuit of this thesis I learned by the verse you instilled in me; Jeremiah 29:11 which says, *"For I know the plans I have for you, plans to prosper you and not to harm you, plans to give you a hope and a future."* Many thanks to my helper, **Sakhile**, who was a mother to my children when I spent sleepless nights at the office.

I would also like to thank my fellow colleagues and friends at the University of Botswana; **Dr Kelly Kgosi, Dr Poloko Ntshwarang** and **Tshepi Tumoyagae** for your prayers. During this PhD process, you turned me into a prayer warrior and taught me that everything is possible when God is invited.

So many other people have contributed a lot to my thesis, I may not be able to list all here but I am sincerely grateful.

ABSTRACT

Title of thesis	:	Development of a Total Quality Management tool integrating sustainability practices to address food waste: A case in a University food service unit
		by
		Boineelo Pearl Lefadola
Supervisor	:	Dr Annemarie Viljoen
Co-supervisor	:	Prof Gerrie du Rand
Department	:	Consumer and Food Sciences
Faculty	:	Natural and Agricultural Sciences
Degree	:	PhD in Consumer Science (Food Management)

The issue of food waste has gained increasing attention worldwide with growing concern for its environmental, social and economic impact. The volume of food waste generated is alarming, with university food service operations around the world generating a million tonnes of food waste annually. In the context of South African university food service units, research demonstrated that a significant amount of food is wasted. Given the magnitude of the problem of food waste and its associated impact, the current study investigated the causes of food waste in the university food service system, and developed and validated a total quality management (TQM) tool integrating sustainability practices to address food waste. The systems theory was applied to address the issue of food waste holistically. The study further applied the food waste hierarchy framework and adopted 'prevention' which is the most favourable and environmentally sound food waste management option. The environmental dimension of the triple bottom line framework of sustainability was also incorporated in the theoretical framework of the study with the interest to consider environmentally friendly strategies. In order to achieve the objectives of the study, a multiphase-mixed methods design comprising three phases (predevelopment, developmental and validation) was employed. In the first phase of the study, a systematic review of the literature was conducted to explore and conceptualise dimensions and indicators of TQM and sustainability practices that prevented food waste. A qualitative case study approach was applied in the second phase in order to investigate the causes of food waste and to gain a deeper understanding of the dimensions and indicators of TQM and sustainability practices that prevented food waste in the specific context of the University food service units. The data collection in this phase involved the integration of four different techniques including document analysis, face-to-face interviews, focus group discussions and participant observation. In the third (validation) phase, two iterations of a modified Delphi technique were employed to validate the tool developed to address food waste.

The findings of the study indicated that the inputs, activities in the functional subsystems, management functions, linking processes, outputs, memory, feedback and environmental factors had an influence on food waste. The findings further demonstrated the importance of the TQM approach as a control element contributing to food waste prevention. The TQM practices revealed as important in preventing food waste are quality practices of management, customer focus, employee management and involvement, process quality management, employee knowledge and education, supplier quality management, information and analysis and process and product quality design. A total of 114 indicators of TQM practices were validated as contributing to food waste prevention. The study demonstrated the importance of food-focused sustainable practices, and five indicators of sustainability were validated as important in preventing food waste. The findings of the study contribute to the literature, methodology and have practical implications for University food service operations. The TQM tool integrating sustainability practices developed in this study can be applied in the different parts of the food service system to prevent food waste. The application of the tool can thus benefit the food service units economically, socially and environmentally. Further research is recommended to empirically test the reliability and validity of the tool in practice.

Keywords: total quality management
sustainability
food waste
University food service operations
Delphi technique

ABSTRAK

Titel van tesis : Ontwikkeling van 'n omvattende kwaliteitsbestuur instrument insluitend volhoubaarheidspraktyke om voedselvermorsing aan te spreek: Gevallestudie in 'n universiteit voedseldienseenheid

deur

Boineelo Pearl Lefadola

Promotor : Dr Annemarie Viljoen
Mede-promotor : Prof Gerrie du Rand
Departement : Verbruikers- en Voedselwetenskappe
Fakulteit : Natuur- en Landbouwetenskappe
Graad : PhD in Verbruikerswetenskap (Voedselbestuur)

Die wêreldwye omgewings, sosiale en ekonomiese impak van voedselvermorsing ontlok toenemend aandag. Die hoeveelheid voedselafval wat jaarliks gegenereer word deur voedseldienseenhede (ongeveer 540 miljoen ton) is kommerwekkend. Navorsing in Suid-Afrikaanse universiteite het aangedui dat 'n betekenisvolle hoeveelheid voedsel ook ter plaatse vermors word. Gegewe die omvang van voedselvermorsing, het hierdie studie ondersoek ingestel na die oorsake van voedselvermorsing binne universiteite se voedseldienstelsels met die doel om 'n omvattende kwaliteitsbestuur (TQM) instrument te ontwikkel en valideer wat volhoubaarheidspraktyke om voedselvermorsing aan te spreek. Die stelselteorie is toegepas ten einde die onderwerp van voedselafval holisties te bestudeer. Die voedselafval hiërargiese raamwerk is toegepas, gebaseer op die standpunt dat voorkoming die mees gewensde omgewingsopsie vir die voorkoming van voedselafval is. Die teoretiese raamwerk wat gebruik is het die omgewingsdimensie van die meervoudige impak-verlaggewing raamwerk vir volhoubaarheid ingesluit, ten einde omgewingsvriendelike strategieë daar te stel.

Om die doelwitte van die studie te bereik, is 'n multi-fase metode gevolg wat uit drie fases (voorontwikkeling, ontwikkeling en validering) bestaan het. In die eerste fase van die studie is 'n sistematiese literatuuroorsig uitgevoer om die dimensies en indikatore van omvattende kwaliteitsbestuur en volhoubaarheidspraktyke om voedselafval te voorkom, te ondersoek en te konsepsualiseer. 'n Kwalitatiewe gevallestudie benadering is in die tweede fase gevolg om

die oorsake van voedselvermorsing te ondersoek, en om te verstaan welke dimensies en indikatore van omvattende kwaliteitsbestuur en volhoubaarheidspraktyke universiteite se voedseldienseenhede gebruik om voedselvermorsing te voorkom. Die data-insameling in hierdie fase het vier verskillende tegnieke geïntegreer, naamlik analise van dokumente, persoonlike onderhoude, fokusgroep besprekings en deelnemende waarneming. In die derde fase is twee rondtes van die aangepasde Delphi tegniek uitgevoer om die instrument wat ontwikkel is om voedselvermorsing te voorkom, te valideer.

Die studiebevindinge dui daarop dat verskeie aktiwiteite in die funksionele substelsels, naamlik bestuursfunksies, skakelingsprosesse, uitsette, geheue, terugvoer asook omgewingsfaktore, ‘n invloed het op voedselvermorsing. Die belangrikheid van totale kwaliteitsbestuur as kontrole om voedselvermorsing te voorkom, is uitgewys. Belangrike stappe van totale kwalieitsbestuur wat uitgewys is om voedselafval te voorkom, sluit in kwaliteitversekering van bestuurspraktyke, verbruikerfokus, die bestuur van werkers en hulle betrokkenheid, kwaliteitsbestuur van prosesse, kennis en opleiding van werkers, kwaliteitsbestuur van verskaffers, inligting en analise van prosesse asook produk-kwaliteit. ‘n Totaal van 114 indikatore ten opsigte van omvattende kwaliteitsbestuurspraktyke wat bydra tot die voorkoming van voedselvermorsing is gevalideer. Die studie beklemtoon die belangrikheid van voedselgefokusde volhoubaarheidspraktyke, en vyf indikatore van volhoubaarheidspraktyke is gevalideer ter voorkoming van voedselafval. Die bevindinge van die studie maak ‘n belangrike bydrae tot die literatuur en metodologie, en het verdere implikasies vir universiteit voedseldienseenhede geïdentifiseer. Die omvattende kwaliteitsbestuur instrument, waarin die volhoubaarheidspraktyke wat in hierdie studie ontwikkel en geïntegreer is, kan in verskillende afdelings van die voedseldiensstelsel toegepas word om voedselafval te voorkom. Voedseldienseenhede kan die instrument toepas om die ekonomiese, sosiale en omgewings impak van hulle praktyke te meet en bestuur. Verdere empiriese navorsing om die instrument te toets vir betroubaarheid en geldigheid word aanbeveel.

Sleutelwoorde: omvattende kwaliteitsbestuur (TQM)
volhoubaarheid
voedselafval
universiteit voedseldienseenhede
Delphi tegniek

TABLE OF CONTENTS

PHASE 2: DEVELOPMENTAL PHASE

LIST OF TABLES

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

LIST OF FIGURES

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

LIST OF ADDENDA

LIST OF ABBREVIATIONS

AYCE	All-you-can-eat
CH_4	Methane
CO_2	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
FAO	Food and Agriculture Organisation of the United Nations
FGDs	Focus Group Discussions
FIFO	First-In, First-Out
FUSIONS	Food Use for Social Innovation by Optimising Waste Prevention Strategies
FSC	Food supply chain
FW	Food waste
GHGs	Greenhouse gases
GMPs	Good Manufacturing Practices
GRA	Green Restaurant Association
HACCP	Hazard Analysis and Critical Control Points
HVAC	Heating, Ventilation, and Air Conditioning
HLPE	High Level Panel of Experts on Food Security and Nutrition
PURCO SA	Purchasing Consortium Southern Africa
ReFED	Rethink Food Waste
SDGs	Sustainable Development Goals
SOPs	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
TBL	Triple Bottom Line
TDZ	Temperature Danger Zone
TQM	Total Quality Management
TRSA	Textile Rental Services Association
UCO	Used Cooking Oil
U.S. EPA	United States Environmental Protection Agency
WRAP	Waste and Resources Action Programme
WWF	World Wide Fund for Nature

Chapter 1: THE STUDY IN PERSPECTIVE

Chapter 1
THE STUDY IN PERSPECTIVE

This chapter focuses on the background and lays the foundation for the general overview of the study. In this chapter the problem statement, objectives, and main constructs will be discussed.

1.1 THEORETICAL BACKGROUND

The following section gives the theoretical background of the main constructs of the study; food waste, university residential food service units, total quality management practices and sustainability practices in the context of food service units.

1.1.1 Food waste in the context of food service units

To date, there is no consistency in the literature on the exact scope of the term food waste (High Level Panel of Experts on food security and nutrition (HLPE), 2014). It is argued that the definition of food waste is not a mathematical or physical law, but has many different logics, which are equally good (Food and Agriculture Organisation of the United Nations (FAO), 2014). Some authors use the term food waste for the food that is generated as waste at the latter stages of the food supply chain; that is, at retail or distribution, and final consumption stages (Gustavsson, Cederberg, Sonesson, Van Otterdijk & Meybeck, 2011; Parfitt, Barthel & Macnaughton, 2010). On the other hand, the concept food loss is related to the decrease in food quantity or quality that occur at the production, post-harvest, and processing stages of the food chain (Gustavsson *et al*., 2011). Since the focus of the study was to investigate the food waste generated at the latter part of the food supply chain in food service operations, the term food waste as opposed to food loss, was adopted. This is consistent with other studies, which focused on food waste generated in food service operations (Charlebois, Creedy & Von Massow, 2015; Goonan, Mirosa & Spence, 2014; Heikkilä, Reinikainen, Katajajuuri, Silvennoinen & Hartikainen, 2016; Kinasz, Reis & Morais, 2015).

The topic of food waste has gained increasing attention worldwide with growing concern for its environmental, social and economic impact (Goonan *et al*., 2014). The volume of food waste generated is alarming. At least 1.3 billion tonnes of food per year is wasted globally (Gustavsson *et al*., 2011). In South Africa, it is indicated that approximately 10 million tonnes of food waste is generated per year (World Wide Fund for Nature-South Africa (WWF), 2017). The limited research available indicates that food services are large generators of food waste (Goonan *et al*. 2014). In university food service settings, it has been found that these institutions around the world generate at least 540 million tonnes of food waste annually (Painter, Thondhlana & Kua, 2016). A study conducted at Rhodes University in South Africa, revealed that an estimated volume of 450 tonnes of food waste was generated annually (Painter *et al*., 2016). According to Marais, Smit, Koen and Lötze (2017), the amount of food waste generated at the Stellenbosch University residence dining halls and cafeterias is increasing, with approximately 26.7% production and plate waste generated from two residential food service units. Given the magnitude of the problem of food waste and its associated impact, food waste prevention strategies are garnering more support than ever in both policy and academic debates (Thyberg & Tonjes, 2016 cited in Painter *et al.*, 2016). Critical to preventing food waste or at least its reduction, is an understanding of the causes of food waste. This area has been under-researched. An understanding of the causes of food waste can provide insights into relevant interventions for food waste reduction and prevention. Additionally, when compared to household food waste studies, there is relatively little known about food waste generation in the context of university food services even though these institutions represent a potentially significant source of food waste (Painter *et al*., 2016). Therefore, there was a need for further empirical research in this area.

Different food waste interventions have been adopted in different food service settings to encourage food waste reduction. These include amongst others; the use of a meal booking system, a tray-less delivery system, using smaller plates, a food waste tracking system, and the use of written messages about food waste (Babich & Smith, 2010; Campbell-Arvai, 2015; Painter *et al*., 2016; Thiagarajah & Getty, 2013; Whitehair, Shanklin & Brannon, 2013). However, food continues to be wasted in the food service sector. This study, therefore aimed to develop and validate a total quality management tool by integrating sustainability practices to address food waste in university residential food service units.

1.1.2 University residential food service units

University residential food service units can be defined as catering facilities for institutions of higher education, such as universities, which provide a catering service to students residing in the university accommodation (Davis, Lockwood, Alcott & Pantelidis, 2012:96). In South Africa there are 26 public universities; a small number compared to other countries; such as the United Kingdom with 90 universities, 97 in Canada, and United States of America with 1 625 public universities (Universities South Africa, 2021). However, food waste can be seen as a concerning issue in universities because of the large and increasing student populations. As a result, the environmental, financial and social implications of their food waste, if any, could be potentially substantial.

Empirical research of food waste in university food services has largely focused on plate waste (Ferreira, Martins & Rocha, 2013; Kim & Freedman, 2010; Kim & Morawski, 2012; Painter *et al*., 2016; Thiagarajah & Getty, 2013; Whitehair *et al*., 2013). Food waste generated in the different subsystems or phases of the university food service system has been given little attention. The magnitude of food waste generated, and causes of food waste at these phases were unknown. Within this context, the study aimed to investigate the causes of the generation of food waste in the university food service sector and develop a tool to address this.

1.1.3 Total quality management practices

Total quality management (TQM) is defined as a management process with a set of practices that are coordinated to ensure that the organisation consistently meets or exceeds quality standards set by customers and other stakeholders (Jaca & Psomas, 2015; Payne-Palacio & Theis, 2016:428). In this study, total quality management was defined as a set of practices applicable throughout the functions and processes of the food service system to consistently meet or exceed the quality standards of products and services offered. The application of TQM practices has been embraced by many firms around the world since the 1980s, especially in industrialised countries (Samson & Terziovski, 1999; Yong & Wilkinson, 2001) following its successful implementation by Japanese companies (Psomas & Fotopoulos, 2010). Since its inception, the application of TQM practices has been a matter of great interest in the manufacturing industry (Sureshchandar, Rajendran & Anantharamen, 2001). Similarly, within the food service sector, TQM practices have been widely adopted in the food manufacturing and processing industry (Beardsell & Dale, 1999; Morath & Doluschitz, 2009; Psomas & Fotopoulos, 2010). The examination of the academic literature showed little work with regards to the application of TQM practices in the catering sector. Residential food service units at the University of Pretoria, like other non-commercial catering facilities, face the challenge of ensuring quality in the production and service of meals. With TQM's main objective being to ensure high quality products and services, the adoption of such a system could lead to improved quality and organisational performance (Samat, Ramayah & Mat Saad, 2006). This also offers the possibility for food waste reduction. The study therefore, sought to develop a total quality management tool that integrated sustainability practices, which could be implemented to address food waste in university residential food service units.

1.1.4 Sustainability practices in food service units

Although there is a growing awareness and attention to sustainability practices (Pinard, Byker, Serrano & Harmon, 2014), there is little known about sustainability practices in the context of food service units and their potential to address the issue of food waste. The High Level Panel of Experts on food security and nutrition (HLPE) (2014) defined sustainability as it relates to the food system: as delivering food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations, are not compromised (Food and Agriculture Organization, 2014). In this study, sustainability practices were defined as the actions taken to ensure that the processes and activities in the food service system used resources efficiently, minimised environmental harm and reduced food waste.

Empirical research on sustainable food systems has largely focussed on agricultural food production practices and rarely addressed sustainability and its potential impact on food waste in food service units. The limited literature available on sustainability in the context of food service operations has no clear focus on the issue of food waste (Bloemhof, Van der Vorst, Bastl & Allaoui, 2015; Dauner, Lacaillee, Schultz, Harvie, Klinger, Lacaille & Branovan, 2011). Sustainable practices have different dimensions. For the purpose of this study, the focus was on environmental sustainability and sustainable food practices. Environmental sustainability practices are those which lower the environmental risk of food service operations and raise ecological efficiency. Sustainable food practices are actions specifically related to food that are taken by the food service operation to minimise harm to the environment and reduce food waste. It appeared important to examine sustainability practices in each of these dimensions as they were likely to influence food waste generation in food service units.

1.1.5 Total quality management practices, sustainability practices and food waste

In the literature, attention has been given to examining the relationship between total quality management practices and performance (Agus & Hassan, 2011; Kaynak, 2003; Patiar, Davidson & Wang, 2012; Sadikoglu & Olcay, 2014; Topalović, 2015), total quality management and innovation (Kim, Kumar & Kumar, 2012; Prajogo & Sohal, 2004) as well as total quality management and customer satisfaction (Kristianto, Ajmal & Sandhu, 2012; Mehra & Ranganathan, 2008; Topalović, 2015). Little attention has been given to examining the influence of TQM practices on food waste generation.

The limited literature available shows that TQM's impact on waste generation has been investigated in other contexts but to a much lesser extent in the catering sector. Askarian, Heidarpoor and Assadian (2010) applied a total quality management approach to healthcare waste management in an Iranian hospital. The results of this study indicated a 26% reduction in medical waste after implementation of the TQM approach to waste management (Askarian *et al*., 2010). Generally, empirical findings support the proposition that TQM is positively linked to overall waste reduction. TQM practices reduce waste through the prevention of errors and the elimination of the need for inspection, which reduces the need for reproduction of products (Rawlins, 2008). Given the lack of information on the influence of TQM practices on food waste, the study would aim to close the existing research gap and make a valuable contribution to the literature.

Likewise, there is little empirical research on the relationship between sustainability practices and food waste. According to HLPE (2014), more sustainable practices are linked to the reduction of food waste while unsustainable practices contribute to food waste. It was therefore, expected that a total quality management tool that integrated sustainable practices could result in the reduction of food waste.

1.2 PROBLEM STATEMENT

The magnitude and monetary value of food waste generated in South Africa raises concern (De Lange & Nahman, 2015; Nahman & De Lange, 2013; Nahman, De Lange, Oelofse & Godfrey, 2012; Oelofse & Nahman, 2013). It is estimated that a third of the food produced for consumption in South Africa is never consumed and ends up in the landfills (World Wide Fund for Nature (WWF), South Africa, 2017). This is approximately 10 million tonnes of food waste per year (WWF, 2017). The total cost of edible and inedible food waste across the food value chain in South Africa is estimated at R75 billion per annum (De Lange & Nahman, 2015). The studies concerning the problem of the levels of food waste in South Africa have focussed on households (Oelofse & Marx-Pienaar, 2016; Oelofse, Muswema & Ramukhwatho, 2018; Ramukhwatho, Du Plessis & Oelofse, 2018; Ramukhwatho, Du Plessis & Oelofse, 2014). As fewer empirical studies (Marais *et al*., 2017; Painter *et al*., 2016) in South Africa have investigated food waste in the context of university food service units, there is a need to study this further.

Food service operations, including the University of Pretoria residential food service units, are not an exception to the problem of food waste. The records from the University (including financial reports and food waste records extrapolated from daily and weekly records) indicated that the total cost of food waste across residential food service units was estimated at R290,650.18 per annum (approximately $20,000); equivalent to nearly 6% of the annual food purchases budget (Van der Westhuizen, 2015). With the increasing pressure from the University's Department of Residence Affairs and Accommodation management for residential food service units to reduce food waste, food service managers are challenged to do so without compromising the quality of food products. The preliminary investigations, in which participant observations and document analysis were conducted at the research site, suggested that the lack of a quality management system at the University's residential food service units contributed to food waste. Implementing a total quality management approach could possibly help reduce food waste and at the same time enhance the quality performance of the food service system. The study therefore, aimed to develop a total quality management tool that integrated sustainability practices to address food waste within the University food service system.

1.3 JUSTIFICATION OF THE STUDY

The issue of food waste is of high priority on the global agenda. The call for the reduction of food waste dates back as far as 1974, when FAO hosted a World Food Conference, and called for attention to the linkage between food waste and food insecurity (FAO, 2014). In September 2015, the United Nations General Assembly in New York adopted the 2030 Agenda for Sustainable Development that includes 17 sustainable development goals (SDGs) (United Nations, 2019). Of these goals, SDG 2 and SDG 12, are the two directly related to this study. Sustainable development goal number two (2) seeks to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture by 2030 (United Nations, 2019). To achieve this, it is important that food waste be reduced at all levels so that the food produced is consumed, and not wasted, hence ensuring food security. Sustainable Development Goal 12: target 12.3, which aims to halve per capita global food waste at the retail and consumer levels by 2030, relates directly to the study (United Nations, 2019). All role players within the food supply chain, including the university food service units are equally challenged to answer this call and minimise food waste.

The interest surrounding the issue of food waste is to some extent driven by its social impact (Abeliotis, Lasaridi & Chroni, 2014; Gustavsson *et al*., 2011; Nahman *et al*., 2012; Ofei, Holst, Rasmussen & Mikkelsen, 2014). A large amount of food that is fit for human consumption, which could potentially feed some of the world's hungry population, is wasted (Gustavsson *et al*., 2011). In South Africa, approximately 26% of households experience hunger, while a further 28.3% are at risk of hunger, yet a substantial amount of food is wasted annually (WWF, 2017). Simultaneously, approximately 10 million tonnes of food are wasted annually (WWF, 2017). Perhaps, most importantly in the context of universities, some students are food insecure yet a proportion of edible food is disposed of. A number of empirical studies (Kassier & Veldman, 2013; Van den Berg & Raubenheimer, 2015) indicated that the magnitude of food insecurity amongst university students was of concern. A study conducted at the University of the Free State in South Africa, indicated that the prevalence of food insecurity among the student participants was 65% (Van den Berg & Raubenheimer, 2015). This indicated that food insecurity in universities was a problem, yet food was wasted. It therefore, appeared important to address the issue of food waste within the university settings.

Food waste has economic implications, such as investments related to the production of food is lost when food is wasted. In South Africa, the total cost of food waste including disposal costs, and the value forgone, was estimated at R75 billion in 2013 (De Lange & Nahman, 2015. Food service units in universities are affected by the economic impact of throwing food away. For example, a study conducted by Painter *et al*. (2016), at Rhodes University in South Africa, estimated that an amount equivalent to US$80 000 per annum was lost to food waste. To curb the costs, it is essential to reduce food waste. Additionally, food waste, particularly if disposed of in landfills, poses major environmental challenges, as it decomposes and produces greenhouse gases (GHGs) - methane and carbon-dioxide (CO_2). These contribute to climatic changes and global warming (Papargyropoulou, Lozano, Steinberger, Wright & Bin Ujang, 2014). In South Africa, discarded food generates 10 million tons of methane (CH_4) and CO_2 a year (Deutsche Welle, 2018). This represents more than 30% of the country's annual greenhouse gas emissions (Deutsche Welle, 2018).

Given the magnitude of food waste and its associated impact, it was important to empirically investigate food waste within the University food service unit setting and further develop and validate a tool to prevent food waste. The tool developed was based on the TQM approach since the literature available showed its impact on waste reduction. For instance, Askarian *et al*., (2010) applied a total quality management approach to healthcare waste management in an Iranian hospital. The results of this study indicated a 26% reduction in medical waste after implementation of the TQM approach to waste management (Askarian *et al*., 2010). Generally, empirical findings support the proposition that TQM is positively linked to overall waste reduction, by preventing errors and eliminating the need for inspection, thus reducing the need for the reproduction of products (Rawlins, 2008). However, the potential influence of TQM practices on food waste in the specific context of food service operations has not been explored in the current literature, the study will therefore close the existing research gap and make a valuable contribution to the literature.

1.4 SIGNIFICANCE AND CONTRIBUTIONS OF THE STUDY

In this section, the theoretical and practical contributions and/or the significance of the study, and the implications for university policy makers are discussed.

1.4.1 Theoretical contributions

The study investigated causes of food waste from the systems theoretical perspective. This represents an important first step towards an improved understanding of the causes of food waste within the university food service setting. Unlike previous studies, a holistic view of the causes of food waste in different subsystems or parts of the university food service system were explored. An understanding of food waste from this perspective is useful in proposing strategies that adequately address food waste in the entire food service system. The study also developed a total quality management tool that integrated sustainability practices to address food waste, which was an aspect that had not previously been researched in the food service area. The study contributed to the limited literature in this context.

1.4.2 Practical contributions

The following subsection discusses the practical contributions of the study, which are improved food security, decreased pressure on resources, economic efficiency and reduced environmental burden.

1.4.2.1 Improved food security

Reducing food waste can potentially reduce food insecurity (Bond, Meacham, Bhunnoo & Benton, 2013; Buzby & Hyman 2012;). The food wasted, which is still potentially fit for human consumption, could potentially feed those in need and thereby contribute to enhancing food security. By reducing food waste, more food could be made available for consumption**.** It is therefore expected that the implementation of the developed tool would reduce food waste thereby improving food security within the university setting.

1.4.2.2 Decreased pressure on resources

The reduction of food waste would decrease pressure on resources or inputs required for food preparation and production. This would require less water, energy and human resources, since increased waste utilises these (Ferreira *et al*., 2013). Reducing food waste would lessen the use of raw materials or food supplies that could have been used in the production of food products but end up being discarded.

1.4.2.3 Economic efficiency

Food waste has economic implications when investments in the production of food are wasted. In South Africa, the monetary value of food waste at household level only, is estimated at approximately R21.7 billion per year, excluding disposal costs (Nahman *et al*., 2012). At a food service unit level, waste directly represents financial costs related to the inputs used (Ferreira *et al*., 2013). Avoiding or reducing food waste can ultimately save residential food service units substantial amounts of money, hence increasing profitability (Ferreira *et al*., 2013).

1.4.2.4 Reduced environmental burden

The implementation of the total quality management tool, integrating sustainability practices in university food service units, was expected to reduce food waste, hence reducing the negative environmental impacts associated with food waste.

1.4.3 Improved policy and decision making

Information generated from the study would place the issue of food waste in context, hence would aid planning and funding decisions on food waste management by the University of Pretoria. The information would benefit the Department of Residence Affairs and Accommodation (Food Service Division) to enable it to make strategic and tactical decisions that would lead to the reduction of food waste.

The literature shows that the government of South Africa has placed an emphasis on the need to divert organic waste (including food waste) from landfills (Nehman *et al*., 2012). According to the 2008 Waste Act and the National Waste Management Strategy, which was effective in November 2011, municipalities were obliged to comply (Nehman *et al*., 2012). The developed tool was in line with this mandate and would assist university food service units to minimise food waste, which would have ultimately reached landfills.

1.5 AIM AND SPECIFIC OBJECTIVES OF THE STUDY

This section of the study describes the main aim as well as the primary objectives and sub-objectives.

1.5.1 Research aim

The overall aim of this study was to develop and validate a total quality management tool integrating sustainability practices, which could be applied to address food waste in university residential food service units. The study was designed to meet the following objectives:

1.5.2 Specific objectives of the study

Objective 1:

To investigate causes of food waste generation in the University food service system.

Objective 2:

To develop a total quality management tool, integrating sustainability practices to address food waste in the university food service system.

- ***Sub objective 2.1***

  To investigate total quality management practices that contribute to the prevention of food waste in university food service units.

- ***Sub objective 2.2***

  To explore sustainability practices that prevent food waste in university food service units.

Objective 3:

To validate a total quality management tool integrating sustainability practices, developed to address food waste in the university food service system.

1.6 STUDY AREA

The study took place at the University of Pretoria located in Pretoria in the Gauteng province of South Africa (Figure 1.1). The University of Pretoria has just over 53 000 registered students with 16 685 undergraduates and 36 467 postgraduates (University of Pretoria, 2019).

The University of Pretoria's residence system has 26 undergraduate residence halls, each located around 13 residential food service units (Department of Residence Affairs and Accommodation, 2018). These residential food service units provide approximately 8 000 students with meals on a daily basis (Muzanechita, 2019). The study was located at the largest residential food service unit at the University – Tuks Monate. The interior and exterior of Tuks Monate is shown in Figures 1.2 and 1.3 respectively.

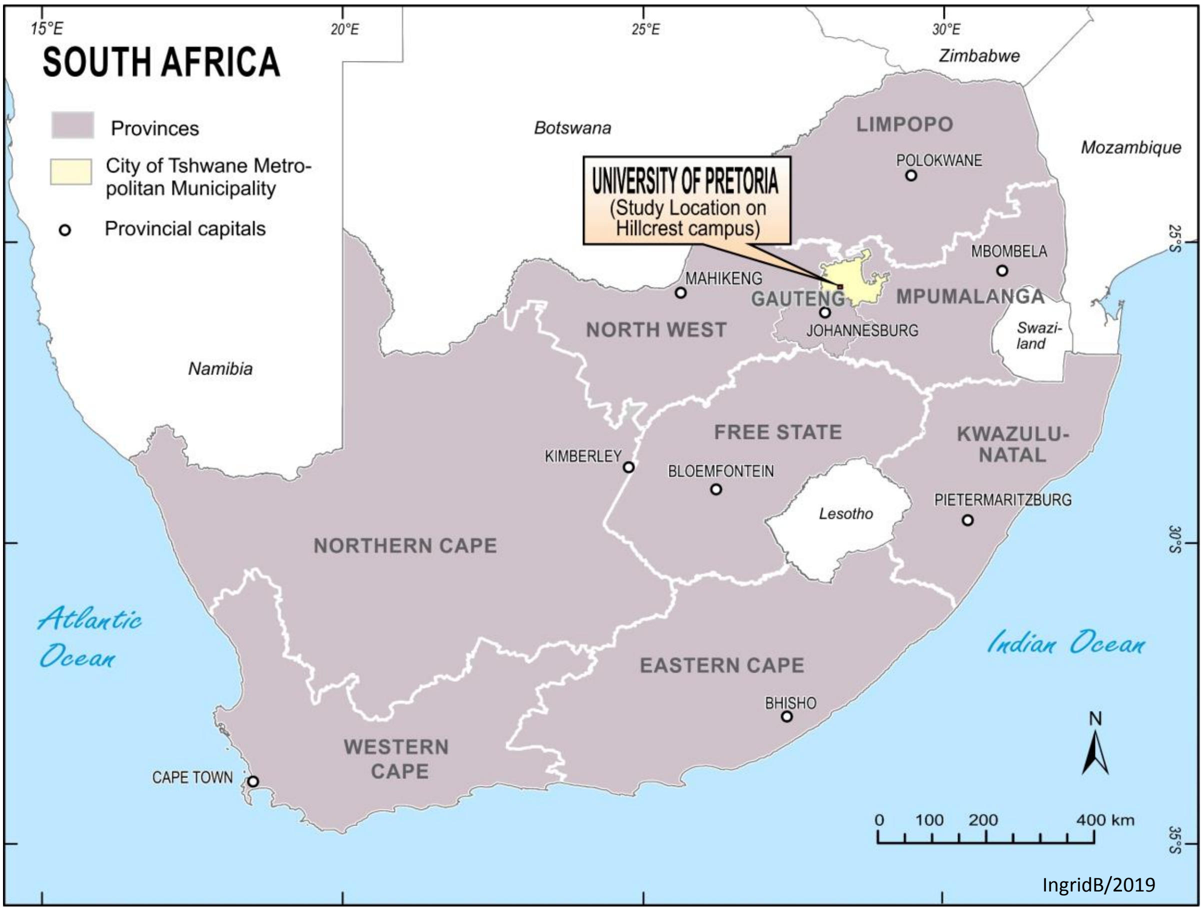


FIGURE 1.1: MAP OF SOUTH AFRICA INDICATING THE STUDY LOCATION – PRETORIA

FIGURE 1.2: THE INTERIOR OF TUKS MONATE RESIDENTIAL FOOD SERVICE UNIT (University of Pretoria, 2014)

FIGURE 1.3: THE EXTERIOR OF TUKS MONATE RESIDENTIAL FOOD SERVICE UNIT (University of Pretoria, 2014)

Tuks Monate is located at Hillcrest, about 2.5 kilometres from the University of Pretoria, Hatfield campus (Figure 1.4). This residential food service unit alone serves a population of approximately 900 students residing at six of the residential halls. Additionally, Tuks Monate serves as is a central production kitchen producing and distributing meals to four satellite residential food service units. Tuks Monate is a non-commercial (institutional) food service operation; that is, the sale of food is secondary to the primary goal of providing education at the institution. Additionally, Tuks Monate is a self-operated food service unit, which is wholly managed and run under the Food Services Division of the Department of Residence Affairs and Accommodation of the University of Pretoria.

1.6.1 The menu

Tuks Monate residential food service unit offers both a fixed menu and a-la-carte menu. Both menus are offered on a 16-day cycle. However, there is an element of flexibility. The menu items are sometimes changed, depending on the availability of ingredients or inventory levels of food items that are about to reach their expiry dates. The food service unit offers three meals per day; breakfast, lunch and dinner during weekdays, while only lunch and supper are provided on weekends. This is a common practice in university residential food service units; for example, the University of Stellenbosch and Rhodes University offer the same number of dining options (Marais *et al*., 2017; Painter *et al*., 2016). For the fixed menu, students are

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FIGURE 1.4: THE LOCATION MAP OF TUKS MONATE RESIDENTIAL FOOD SERVICE UNIT (University of Pretoria, 2019)

supposed to book meals at least 12 hours in advance using the computerised meal booking system. The system allows students to cancel their bookings 12 hours in advance. At the University of Stellenbosch, students have to book meals or cancel bookings 48 hours in advance (Marais *et al*., 2017). The long lead time of 48 hours was found to contribute to food waste generation (Marais *et al*., 2017). The a-la-carte menu offers a wide range of unbooked menu items.

1.6.2 Food service system

Tuks Monate residential food service unit applies three types of food service systems; the conventional, ready-prepared and commissary. The conventional food service system is predominantly used at Tuks Monate. With this system, the food service unit prepares and cooks food from scratch and then holds it in heated cabinets until the time of service. When needed, the food is transferred from the heated cabinets to the bain-maries in the serving area of the cafeteria. Some menu items at Tuks Monate are produced through a ready-prepared food service system (cook-chill and cook-freeze) where menu items are not produced for immediate service but are held chilled or frozen until heated for serving (Gregoire, 2013:69). Additionally, Tuks Monate being a central kitchen, produces and distributes menu items to several remote sites for final preparation and service (commissary food service system). Some menu items are delivered to the remote sites, either hot or cold, ready to serve, while others are delivered chilled or frozen, then reheated. These food service systems influence food waste generation or its prevention to varying degrees and are shown schematically and discussed in Chapter 3.

1.6.3 Distribution and service

Distribution of food at Tuks Monate food service unit ranges from simple to complex. Where the food is produced and served immediately to customers using the conventional food service system, distribution is relatively simple (Gregoire, 2013:206). Students queue for food in a traditional cafeteria style, select their preferred menu items, which are portioned onto either plates or into disposable containers. They have a choice to either consume their meals off premises or to eat at a table within the food service unit.

Where meals are produced at Tuks Monate then distributed to remote sites (commissary food service system), a decentralised meal assembly system is used. The food is produced at Tuks Monate and transported to various remote sites for assembly and service. To ensure that the right temperature of food is maintained, food is transported either hot, cold or frozen in insulated carriers.

Different methods of service are used to present food to the customers at Tuks Monate. These include cafeteria- and buffet service. For the cafeteria service, there is a straight-line counter arrangement where students maintain a queue, order and pay for meals, which are portioned or assembled by the front-of-house staff. During the course of data collection for this study, Tuks Monate food service unit offered the all-you-can-eat (AYCE) or buffet service to students periodically, during selected weekends. The intention was to break the monotony. In this type of service, students were allowed to choose the variety of menu items they preferred and dished for themselves. According to Papargyropoulou *et al.* (2016), the buffet service generates a substantial amount of food waste compared to most other types of service. This is consistent with the findings of this study as students dished more food than they could consume, which ended up being discarded.

1.6.4 Food service design and layout

A functional kitchen design and dining room layout is a critical feature of a food service facility as it can help improve the efficiency of operations (Zijlstra & Mobach, 2011). A well-designed kitchen and layout can minimise backtracking and cross-over movement of food and people, which can influence food waste generation or its prevention. Additionally, it is argued that a functional design and layout has a positive influence on customer satisfaction (Zijlstra & Mobach, 2011). The design and layout of Tuks Monate is illustrated in Figure 1.5 – next page).

As shown in the diagram (Figure 1.5) the food service unit has all the crucial spaces, which include the following:

- ⇒ The receiving area;
- ⇒ Dry storage;
- ⇒ Cold storage;
- ⇒ Hot food production area;
- ⇒ Cold food production area;
- ⇒ Ware washing and scullery;
- ⇒ Cafeteria service area;
- ⇒ Cafeteria dining area;
- ⇒ Offices; and
- ⇒ Bathrooms and changing rooms.

The design and layout of the facility is adequate to support the activities of the operation and is expected to contribute positively to food waste prevention. For example, the arrangement and adequacy of the storage space at Tuks Monate allows food service workers to store food appropriately thus minimising storage waste.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

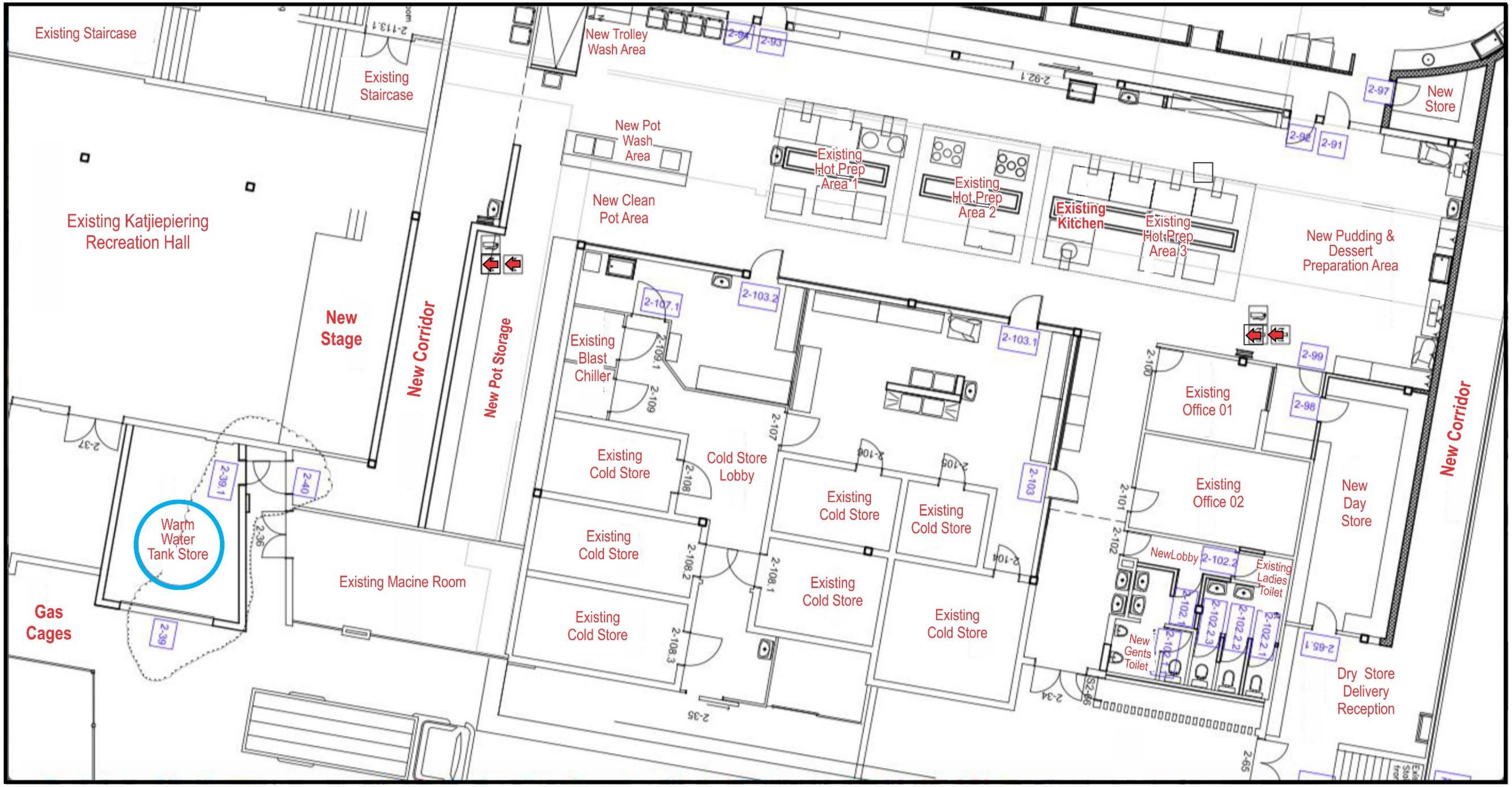


FIGURE 1.5: DESIGN AND LAYOUT OF TUKS MONATE RESIDENTIAL FOOD SERVICE UNIT (UP Food Services, 2019)

1.7 OVERVIEW OF METHODOLOGY

To analyse the problem a preliminary study was conducted. This was followed by the main study which employed a multiphase mixed methods design comprising of three phases; predevelopment-, developmental- and the validation phase. In the first phase of the study a systematic review was conducted to explore total quality management practices and sustainability practices that can be applied to address food waste in food service units. At the end of this phase a preliminary tool was developed. The second phase – the developmental phase, focused on further refining the preliminary tool developed in the first phase into a tool that is specific to the context of university food service units. A number of qualitative data collection methods were used to address the objectives of this phase. This included document analysis, face-to-face interviews, focus group discussions and participant observation. Data was collected from food service workers at the residential food service unit at the University of Pretoria. The third phase – a validation phase, involved validating the tool developed in the previous phase with the application of two iterations of the e-Delphi survey. The e-Delphi survey was electronically completed by experts with experience in university food services and/or with a food waste background. Qualtrics software was employed to run the electronic based survey. To analyse data in phases one and two, thematic analysis was employed. In phase three, data was analysed using both thematic analysis and descriptive statistics.

1.8 STUDY PLAN

The study plan is presented in Figure 1.6. It illustrates the steps taken to initiate the study, and the procedures that followed until completion.

1.9 STUDY LAYOUT

The thesis is composed of eight chapters as outlined in Figure 1.7. The chapters are organised in a way that allows for logical coherence and a clear linkage between these. The following subsection gives an account of each chapter.

- **Chapter 1:** The study in perspective.

This chapter gives an introduction and background to the study. It provides a detailed description of the study area – Tuks Monate food service unit of the University of Pretoria. Chapter 1 also presents the background information and clearly discusses the problem to be investigated. Theoretical and practical contributions of the study are presented to show its value. The reason for the study is elaborated on in this chapter, together with the aim and objectives. The chapter ends with an overview of the methodological approach, study plan, and the layout as well as the definitions of important terms.

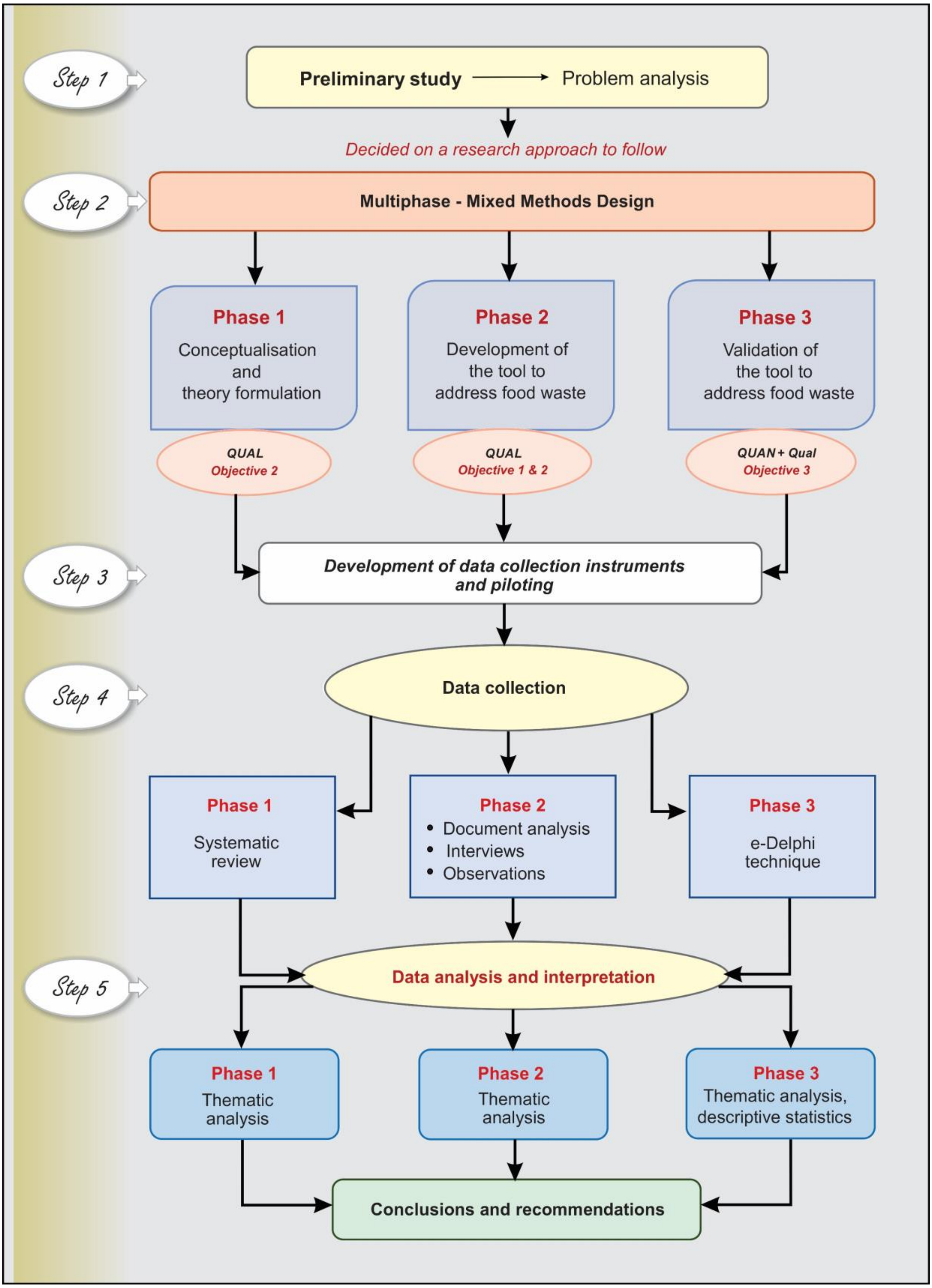


FIGURE 1.6: THE STUDY PLAN

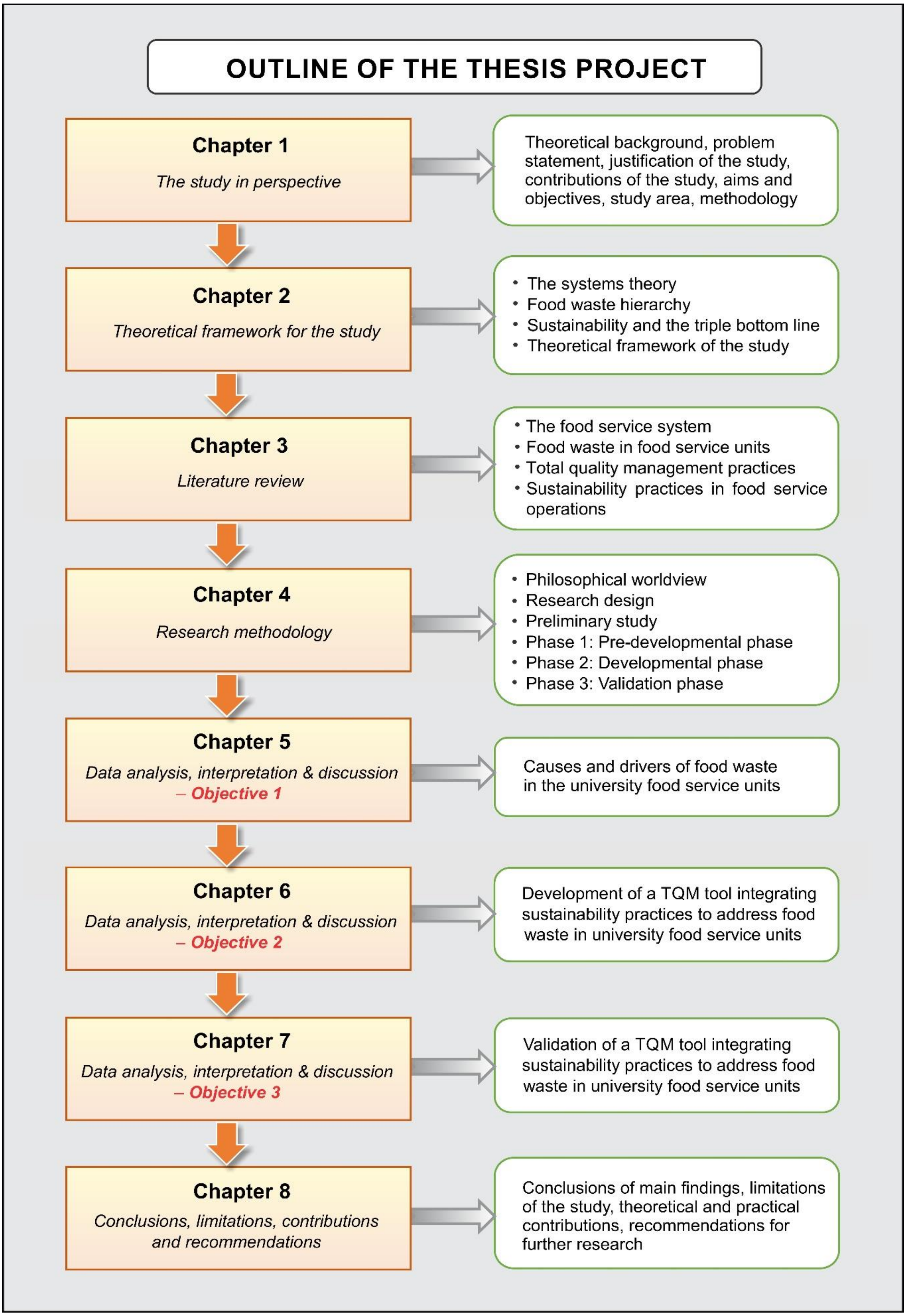


FIGURE 1.7: STUDY LAYOUT

- **Chapter 2:** Theoretical perspectives of the study.

Chapter 2 presents the theory and theoretical frameworks supporting the study. Specifically, the theory that guided the study, which is the application of the systems theory, is discussed. The chapter further elaborates on the two theoretical frameworks; the food waste hierarchy and the triple bottom line. These frameworks are discussed in depth, and their relevance and application to the study is explained. The chapter concludes with a presentation of the theoretical framework, which was formulated from the integration of the systems theory, food waste hierarchy and the environmental sustainability component of the triple bottom line.

- **Chapter 3:** Supporting literature review.

In Chapter 3, the main constructs of the study, which are; the food service system, food waste, total quality management practices and sustainable practices in food service operations, are discussed in depth. The areas within the food service system, that were reviewed include; an overview of the food supply chain, the food service industry including both the commercial and non-commercial segments, the university residential food services and different types of food service systems. The discussion on the food waste construct covers; the definition of food waste, the magnitude of food waste, causes of food waste, importance of food waste and food waste prevention approaches applied in the food service system.

- **Chapter 4:** Research methodology.

In Chapter 4, the methodology and the philosophical worldview that were followed in the study, are discussed. A multiphase mixed methods design was used. It consisted of three phases; predevelopment-, developmental- and validation phases. The research design is explained, and its relevance is justified. The sampling procedures, data collection and data analysis techniques are discussed. The chapter also covers ethical considerations and measures employed to ensure validity and reliability of the study.

- **Chapter 5:** Causes of food waste in the university food service system.

This chapter reports findings and discusses causes of food waste in the food service system. The causes are discussed from a systems' theoretical perspective, and focus on the causes of food waste in the inputs, transformation, outputs, controls, memory, feedback and environmental factors subsystems.

- **Chapter 6:** Development of the TQM tool integrating sustainability practices to address food waste in the university residential food services.

In this chapter, the tool that was developed, based on data from the systematic review and qualitative data collection (document analysis, face-to-face interviews, focus group discussions and participant observation) is presented. The tool focusses on two major dimensions; total quality management practices and sustainability practices that can prevent food waste in the university food service units.

- **Chapter 7:** Validation of the TQM tool integrating sustainability practices to address food waste in the university residential food services.

This chapter presents the findings of the validation of the tool that was conducted through an e-Delphi technique. Items removed, added and maintained from the original tool are presented and discussed. The chapter ends with a presentation of the validated tool that can be adopted to address food waste in university food service units.

- **Chapter 8:** Conclusions, limitations of the study, contributions to theory and practice, recommendations for further research.

This is the final chapter and presents the conclusions to the main findings of the study. The limitations of the study and recommendations for further research are outlined and discussed. The chapter also provides the implications for practice in food services and theoretical contributions of the study.

1.10 SUMMARY

This chapter provided the background to the study, highlighted the problem statement, the contributions of the study and justified its need and relevance. The aim and objectives are outlined, as well as a detailed description of the study area. An overview of the methodology, the study plan and study layout were presented. Additionally, terms important in this study were provided.

The next chapter provides a discussion on the theoretical perspectives, that is, the theories and theoretical frameworks guiding the study and indicates how they were applied.

1.11 DEFINITION OF TERMS

A-la-carte*:* method of pricing menu items individually (Gregoire, 2013:494).

Assembly / serve food service*:* a convenience system that depends on purchasing fully prepared foods, which are stored and assembled, heated and served when required by customers (Ahmed, Jones, Redmond, Hewedi, Wingert & Gad El Rab, 2015).

Batch cooking*:* cooking smaller quantities of menu items as required for service (Gregoire, 2013:494).

Commercial food service*:* food service establishments in which the sale of food is the primary function of the operation, and profit is the desired output (Gregoire, 2013:11).

Commissary food service*:* 'A large, central production with centralised food purchasing and delivery of prepared foods to service (satellite) units located in separate, remote areas for final preparation or assembly, and service.' (Payne-Palacio & Theis, 2016:66). Food service organisations with many serving units, sometimes widely separated as in a large city university system, often apply the commissary system as a way to consolidate operations and reduce costs (Ahmed *et al*., 2015; Payne-Palacio & Theis, 2016:66).

Cook-chill: a food production method in which food is prepared and cooked by conventional or other methods, followed by rapid cooling to 3°C within 90 minutes, using a blast chiller and refrigerated for use at a later time (Payne-Palacio & Theis, 2016:64; Yusof, Zahari, Abdullah, Ghani & Abdullah, 2018).

Cook-freeze: a system where food preparation and production are followed by fast freezing and storage in a frozen state for use at a later time (Ahmed *et al*., 2015; Yusof *et al*., 2018). In the cook-freeze method, a blast freezer or cryogenic freezing system is required to freeze foods quickly and prevent cell damage (Payne-Palacio & Theis, 2016:65).

Controls*:* the external and internal plans, and legal documents that affect and direct the way in which the organisation functions (Gregoire, 2013:496).

Conventional food service*:* foods are purchased in various degrees of processing for production, distribution and service on the same premises (Gregoire, 2013:496). In this system, prepared food is served to customers soon after preparation (Payne-Palacio & Theis, 2016:63).

Environmental factors*:* external forces including the social, economic, technological, demographic and political factors that can impact the operation of the food service system (Goonan *et al.*, 2015; Greigore, 2013:97).

Feedback*:* the processes by which the system continually receives information from the internal and external environment necessary for the food service operation to make adjustments in performance to achieve set goals (Goonan *et al*., 2015; Jagustović, Zougmoré, Kessler, Ritsema, Keesstra & Reynolds, 2019; Kast & Rosenzweig, 1972).

FIFO (first in, first out)*:* Inventory valuation method that means the food that was received first should be produced and sold to customers first (Davis *et al*., 2012:251). The newest stock should be used after the old stock (Davis *et al*., 2012:251).

Food service*:* the serviced provision of food and beverages (meals) to consumers outside the home, for consumption both in and out of the home (Edwards, 2013; Martin-Rios, Demen-Meier, Gössling & Cornuz, 2018).

Food supply chain*:* the food pathway from agricultural farms to consumers that entails activities conducted throughout the primary production, postharvest handling and storage, processing and packaging, distribution, retail and food service, and final consumption by consumers (Govindan, 2018).

Food waste*:* the edible parts of food intended for human consumption that are lost or discarded at some point along the food service system. Additionally food waste can be defined from a monetary perspective as (1) the amount of food directed to other uses other than the primary purpose for which it was procured by the food service unit, which is the sale of food items to consumers, (2) the loss of economic value-add linked to the degradation of the quality of food such as freshness, shape, colour, consistency, and taste, to the point that they are close to being lost (High Level Panel of Experts on Food Security and Nutrition, 2014).

Food waste hierarchy*:* a waste management framework that assists in the identification of the most appropriate solution to food surplus and food waste once it has been generated (Papargyropoulou, Wright, Lozano, Steinberger, Padfield & Bin Ujang, 2014).

Inputs*:* any human, physical or operational resources required indirectly or directly in the process of producing outputs (Fan & Fang, 2019; Jagustović *et al*., 2019; Ringel, Hiller & Zietsma, 2018).

Memory*:* all the stored information that provides past records of the food service system (Gregoire, 2013:501). Examples of such records include; inventory records, financial records, forecasting, personnel records, meal statistics, recipes and menus (Spears & Vaden, 1985:36)

Non-commercial food service*:* food service operations in which food provision is secondary to the goal of the organisation (Gregoire, 2013:14).

Outputs*:* these are goods and services that result from processing and transforming inputs (Jagustovic *et al*., 2019; Lai & Huili Lin, 2017; Ringel *et al*., 2018). In the context of food service organisations this includes; the desired quantity and quality of food, customer satisfaction, employee satisfaction and financial accountability (Gregoire, 2013:7).

Ready-prepared food service*:* a food service system where menu items are produced and held chilled or frozen until heated for serving (Greigoire, 2013:69).

Sustainability*:* actions taken to ensure that the processes and activities in the food service system are carried out in a manner that use resources efficiently, minimise environmental harm and reduce food waste.

Systems theory*:* a theoretical perspective that views an organisation holistically, with a collection of interrelated and interdependent parts unified by design to achieve a predetermined objective within the food service unit (Goonan *et al*., 2014).

Total quality management*:* a set of practices applicable throughout the functions and processes of the food service system to consistently meet or exceed the quality standards of products and services offered (Jaca & Psomas, 2015; Payne-Palacio & Theis, 2016:428).

Transformation*:* processes and activities performed to convert inputs into finished goods and services or achievable goals (Amissah, Mensah & Antwi, 2015; Ramosaj & Berisha, 2014).

Triple bottom line*:* a sustainability concept that integrates economic, social and environmental responsibilities of an organisation (Jackson, Boswell & Davis, 2011).

University food service units*:* catering facilities for institutions of higher education, which provide catering services to students staying within the university accommodation facilities (Davis *et al*., 212:96).

Chapter 2: THEORETICAL FRAMEWORK FOR THE STUDY

Chapter 2

THEORETICAL FRAMEWORK FOR THE STUDY

This chapter focuses on the discussion of the theory that predominantly guided this study – the systems theory, and how it is applied to this study.

The chapter further elaborates on two theoretical frameworks supporting the study – the food waste hierarchy and the triple bottom line.

2.1 INTRODUCTION

The systems theory was applied to investigate and address the problem of food waste in the university food service system. The study focused on the entire food service system by conducting an in-depth investigation on how each part of the system or subsystems and their interrelatedness contributed to food waste generation. The study further developed a total quality management tool (in the control element) that prevents food waste. Sustainability is integrated into the systems model, with an indication of sustainable inputs, sustainable practices that prevent food waste in the transformation subsystem, and sustainable outputs. In line with the objectives of the study, that is, to prevent food waste in the university food service units, the study applied the food waste hierarchy framework and adopted 'prevention', which is the most favourable and environmentally sound food waste management option. The sustainable practices to address food waste in the university food service units are in line with the environmental dimension of the triple bottom line framework of sustainability.

2.2 THE SYSTEMS THEORY

The following section includes a discussion on the systems theory, its historical background, characteristics and how it is applied in food service organisations. The section further included the topics of total quality management and sustainability practices in the context of the systems theory.

2.2.1 What is the systems theory?

According to Mele, Pels and Polese (2010:127), the systems theory is conceptualised as a theoretical perspective that analyses a phenomenon seen as a whole and not as simply the sum of elementary parts. It is an orderly grouping of interdependent components for the purpose of attaining a common goal (Mockler, 1968). In the context of food service operations, the systems theory is commonly defined as a theoretical perspective that views an organisation holistically with a collection of interrelated and interdependent parts unified by design, to achieve a predetermined objective within the food service unit (Goonan *et al*., 2015). The systems theory can also be described as an approach that encompasses three fundamental concepts: systems philosophy, systems analysis, and systems management (Figure 2.1) (Spears & Vaden, 1985:25).

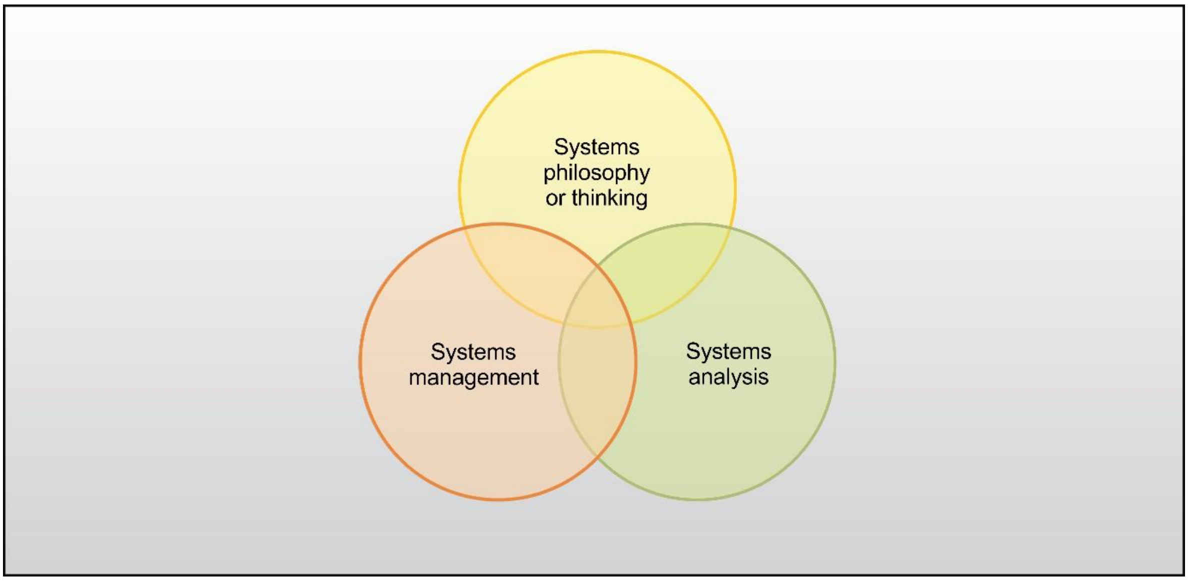


FIGURE 2.1: THE SYSTEMS APPROACH (Spears & Vaden, 1985:25)

The systems philosophy is a way of thinking about a phenomenon holistically, including thinking about subsystems with an emphasis on their interrelationships and interdependencies (Mabogunje, 1970; Mease, Gibbs-Plessl, Erickson, Ludwig, Reddy & Lubchencho, 2017; Payne-Palacio & Theis, 2016:60; Spears & Vaden, 1985:25). Systems analysis is a methodological approach for problem-solving or decision-making (Spears & Vaden, 1985:25). It can be applied to generate concepts, ideas and interventions for a specific set of problems (Stewart & Ayres, 2001). Furthermore, it can be applied to facilitate problem-solving and decision-making for identified problems (Goonan *et al*., 2015). The third concept, systems management, refers to the application of systems theory to manage organisational systems or subsystems (Payne-Palacio & Theis, 2016:60).

The three approaches of the systems theory were applied to a varying degree. The food service system was viewed holistically and considered how each subsystem contributed towards food waste generation or its prevention, and/or how it influenced other subsystems to generate or prevent food waste. Systems analysis was applied to develop the tool to address food waste. Food waste prevention strategies were adopted on the basis of their overall influence on food waste at the organisational level, the subsystem itself and interrelated subsystems. The management of a system, which involves monitoring different subsystems and making the necessary adjustments to prevent food waste was considered and discussed in various sections of the study.

2.2.2 Historical perspective of the systems theory

The systems theory has its theoretical foundation in earlier management theories and has developed into diversified areas such as: scientific management, the human relations movement, operations research, mathematics, social psychology, biological sciences, biochemistry, astrophysics, cybernetics and many other fields (Johnson, Kast & Rosenzweig, 1964). As a result, there are multidisciplinary perspectives of systems theories including: service systems, reticular systems, living systems, economic systems, social systems, institutional systems, ecological systems and technological systems (Mele *et al*., 2010). A summary of the historical evolution of the systems theory is illustrated in Figure 2.2. In the following section, the discussion includes how the systems theory has evolved from a historical standpoint and how the evolution is relevant to the study.

- **1940s**

The general systems theory was pioneered in 1949 by the biologist Ludwig von Bertalanffy (Von Bertalanffy, 1951). However, he had already presented his original work on the general systems theory in 1937 at a talk hosted at the University of Chicago (Drack & Schwarz, 2010). According to the literature, Von Bertalanffy's original work theorised that the fundamental character of the living thing is its organisation (organised entity or organism), with a complex set of interacting elements (Adams, Hester & Bradley, 2013; Rousseau, 2015; Von Bertalanffy, 1972). This is an important aspect that informed this study, in that the food service organisation is viewed as a system with a set of interdependent and interrelated parts working together to achieve set goals. In the late 1940s, the mathematician and philosopher, Nobert Wiener initiated a new scientific theory; cybernetics (Seising, 2010). The central notion of cybernetics is that of feedback, which assumes that the performance of a machine may be corrected and guided by information on its own performance (Lilienfeld, 1975). The concept of feedback is important and relevant of how operations in different subsystems of the food service organisation generate or prevent food waste. This informs the adoption of strategies that prevent food waste in the university food service sector.

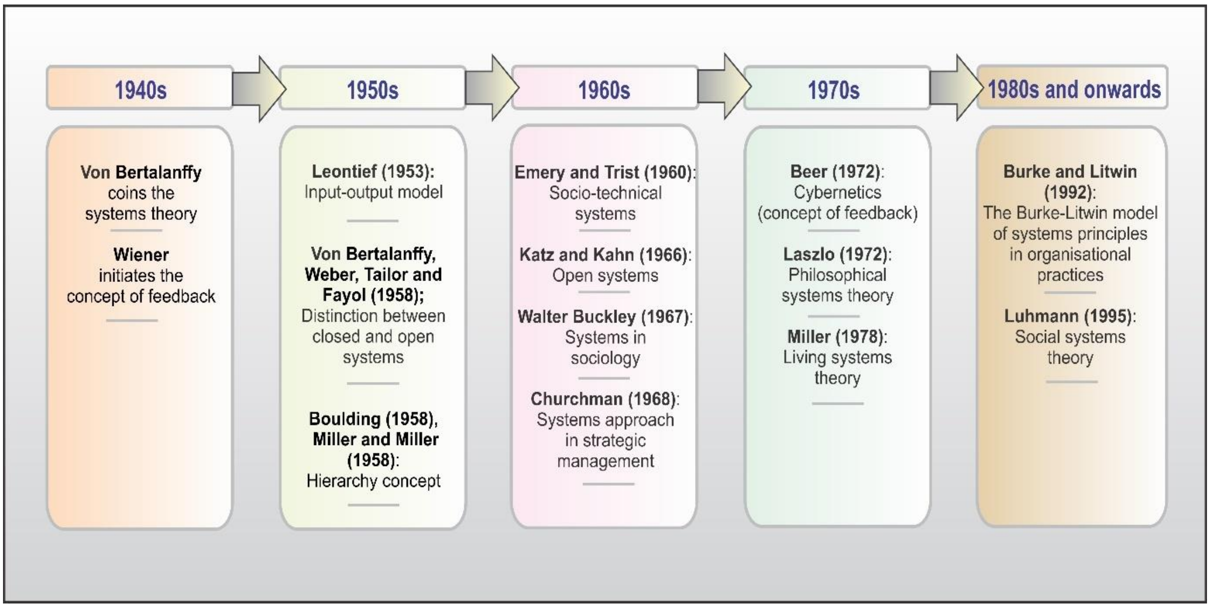


FIGURE 2.2: HISTORICAL EVOLUTION OF THE SYSTEMS THEORY

- **1950s**

Building on the general systems theory, many concepts were developed over the years. Around 1956, Von Bertalanffy introduced an essential distinction between closed and open systems (Caws, 2015). Contrary to what was proposed by classical school theorists Weber, Tailor and Fayol, who viewed organisations as a closed system, Von Bertalanffy argued that closed systems thinking was not appropriate to study biological systems because these interact with their environment (Chikere & Nwoka, 2015:3-4). He emphasised the importance of the relationship between the organisations and their environment - open systems theory (Mele *et al*., 2010). Based on this conceptualisation, Von Bertalanffy stressed holism while solving organisational problems (Kast & Rosenzweig, 1972). In 1954, Kenneth Boulding the economist, Anatol Rapoport the mathematician, and Ralph Gerard joined the general systems theory movement and founded the Society for General Systems Theory (Adams *et al*., 2013). Their mandate was to explore and promulgate the tenets of systems thinking (Lilienfeld, 1975). In his 1956 work, Kenneth Boulding ‘carried the general systems theory a step further by defining nine levels of systems, starting with the most simple and dynamic – the anatomy and geography of the universe, and ending with the most dynamic (transcendental systems)' (Mockler, 1968:53). This led to the arrangement of empirical fields in a hierarchy of separate systems, which in turn are components of larger systems; system of systems (Boulding, 1956; Mockler, 1968). Another concept of the systems theory is the input-output model, which was introduced by Wassily Leontief in 1953 (Miller & Miller, 1995). This concept analysed the flow of goods and services from an economic standpoint (Miller & Miller, 1995). Different scholars continued to apply the systems theory in different fields. In 1956, James Grier Miller and his wife made a significant theoretical contribution to the integration of behavioural sciences to the systems concept (Hammond & Wilby, 2006). Most of these concepts and assumptions were applied in this study, as elaborated in the sections to follow.

- **1960s**

During this era, numerous scholars from different disciplines; sociologists, psychologists, political scientists, environmentalists continued to proclaim the importance of systems-thinking. They acknowledged that elements are interrelated and should be analysed holistically, not in isolation (Lilienfeld, 1975). In 1960, Emery and Trist theorised organisations as socio-technical systems, viewing the fundamental components of organisations as the social component (human), and a technical component (machines and technology) (Mele *et al*., 2010). This is an important observation that has implications on food service systems as their operation depends on the complex interaction of food service workers, equipment and technology that may have a bearing on food waste generation or its prevention. In the area of social psychology of organisations in 1966, Daniel Katz and Robert Kahn integrated the concept of open systems. They developed a model for the interpretation of organisational actions in terms of input, throughput and output (Ramosaj & Berisha, 2014). This was an important development that influenced the interpretation of the food service organisation as an open system. In 1967, Walter Buckley, an American sociologist was the first to apply the systems theory in sociology (Buckley, 1967). His approach was an amalgamation of various concepts of the systems, such as feedback, control and self-regulation (Ramosaj & Berisha, 2014). In 1968, Churchman argued that the systems approach was imperative for strategic management. He identified five essential elements of a system: goals and objectives of the system, assessment of the systems' environment, organisational inputs, identification of the organisation's operations, and development of the management function (Churchman, 1968). In this study, these concepts were applied to investigate how they influenced food waste generation and its prevention.

- **1970s**

The work of Beer (1972) on cybernetics further demonstrated the concept of feedback on how the system has the ability to change behaviour in response to the changing environment (Mele *et al*., 2010). In 1972, Evrin Laszlo proposed a philosophical systems theory that integrated the concepts of the systems theory, emphasised a holistic view of the system as well as systems thinking (Adams, 2012). In 1978, James Grier Miller pioneered the living systems theory and contributed substantially to the application of the systems theory from the narrower area of biological systems to an approach applicable to a variety of living systems (Hammond & Wilby, 2006; Járos, 2000). Miller described living systems as open systems that interact with the environment, have goals, subsystems and a hierarchy from cells to supranational systems (Adams, 2012). The same concepts were applied to describe the food service system in this study.

- **1980s onwards**

From the 1980s to date, a wide range of scholars applied the systems theory in their own areas of specialisations. The theorists, who made a profound contribution during these times, were Burke and Litwin. In 1992, they described an organisation as a system through the Burke-Litwin model, which indicated the applicability of the systems' principles in organisational practices (Ramosaj & Berisha, 2014). In 1995, the German sociologist, Niklas Luhmann developed the social systems theory and introduced relevant aspects to his theory, such as the notions of system differentiation, communication, polycontexture, and structural coupling (Meyer, Gibson & Ward, 2015). Though these aspects are not applied in this study, these developments are a clear indication of the growth and development of the systems theory across diverse areas.

2.2.3 The historical evolution of systems theory in the food service sector

This section focuses on the historical evolution of the systems theory in the specific context of food service operations. In the literature on the food service industry, mention is made of the application of the systems theory in the food service sector from the late 1960s and early 1970s (Spears & Vaden, 1985:24).

2.2.3.1 1965 – Ostenso and colleagues

In 1965, Ostenso, Moy and Donaldson applied a systems analysis approach to develop a generalised simulator that was used to determine the optimum combination of customers, service times, and operational rules for cafeterias (Cloninger, 1986; Ostenso, Moy & Donaldson, 1965). This approach proved to be economically beneficial to food service operations (Cloninger, 1986).

2.2.3.2 1968 – Livingston

In 1968, Livingston showed the application of the systems approach in food service operations (Spears & Vaden, 1985:24). Livingston conceptualised a food service system as an integrated programme in which the procurement, storage, preparation, and service of food and beverages (**transformation**), and the equipment and methods required (**inputs**) to accomplish the objectives, were fully coordinated for minimum labour, optimum customer satisfaction, quality and cost control (**outputs**) (Shaffer, 1979:11). Livingston further demonstrated five different cases in which a number of economic problems in food service were resolved through the application of the systems approach (Shaffer, 1979).

2.2.3.3 1969 – Gue, Konnersman and Freshwater

In 1969, a number of researchers applied the food service systems model in their studies. Gue introduced a conceptual view of a hospital dietary department as a system (Gue, 1969). He emphasised the major aspects of the system as; the recipe, menu plan, inventory, purchasing, production, and data processing (Shaffer, 1979). In the same year, Paul Konnersman viewed the hospital dietetics department as a two-part logistical system; processing and information, and control, each with various subsystems (Konnersman, 1969). He accentuated the input-output flows of the system; viewing the initial input as the diet order, which flows through the information aspect of the system until the vendor orders are placed and the food is purchased, processed, and served to the patient (Shaffer, 1979). In 1969, Freshwater proposed a model that illustrated a food service system with a suggestion of the interrelationships of the subsystems (Freshwater, 1969; Shaffer, 1979). The model emphasised the concept of holism and interrelationships, which indicated the importance of considering the effects of current practices and proposed changes to subsystems, on the system as a whole (Shaffer, 1979).

2.2.3.4 1980 – Vaden

In 1980, A.G. Vaden, former Dean of the School of Home Economics and Professor of Institutional Management at the University of Southern Mississippi, conceptualised a systems model for evaluating food service operations (Vaden, 1980). The model was refined by M. Spears, former Professor and Head of the Department of Dietetics, Restaurant and

Institutional Management at Kansas State University (Puckett, Connell, Dahl, Jackson & McClusky, 2005). During the 20th century, researchers in the field of food service management continued to apply the systems theory and refined it for specific purposes in their fields.

2.2.3.5 2015 – Goonan and colleagues

In 2015, Goonan and colleagues proposed a systems-practice framework that integrated social practice theory into the existing food service systems model (Figure 2.3). The proposed model was applied to understand food waste in the food service system from the perspective of social practices. Practitioners in food service operations can apply the model to understand positive practices to prevent food waste and ensure further systemisation; alternatively, how to break negative practices that generate food waste (Goonan *et al*., 2015).

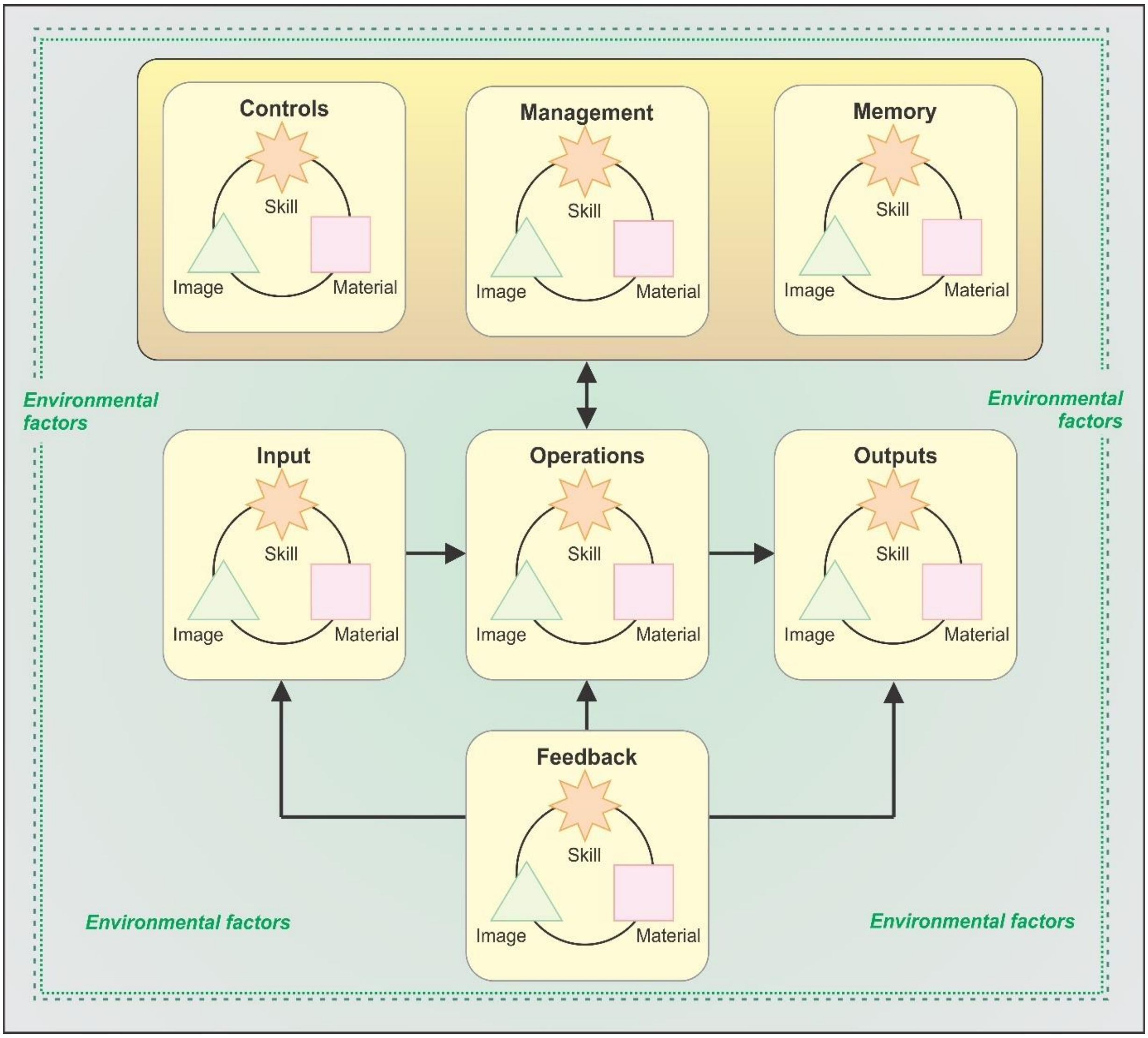


FIGURE 2.3: THE PRACTICE-SYSTEMS THEORY ADDRESSING FOOD WASTE (Goonan *et al*., 2015:83)

2.2.4 Characteristics of the systems theory in the context of the study

The pioneer of the systems theory, Ludwig von Bertalanffy, emphasised the concept of the open systems (Johnson *et al*., 1964). As discussed above in the sections on the historical perspectives of the systems theory, the basis of open systems is that an organisation continually interacts with its external environment, and is composed of interrelated and interdependent elements that need to be viewed holistically (Cornell & Jude, 2015; Kast & Rosenzweig, 1972; Mele *et al*., 2010). Elements, outside the system's boundaries and its control, have an impact on the system and vice versa (Jagustovic *et al*., 2019). In this study, it was assumed that the food service organisation is an open system with a number of unique characteristics as shown in Figure 2.4.

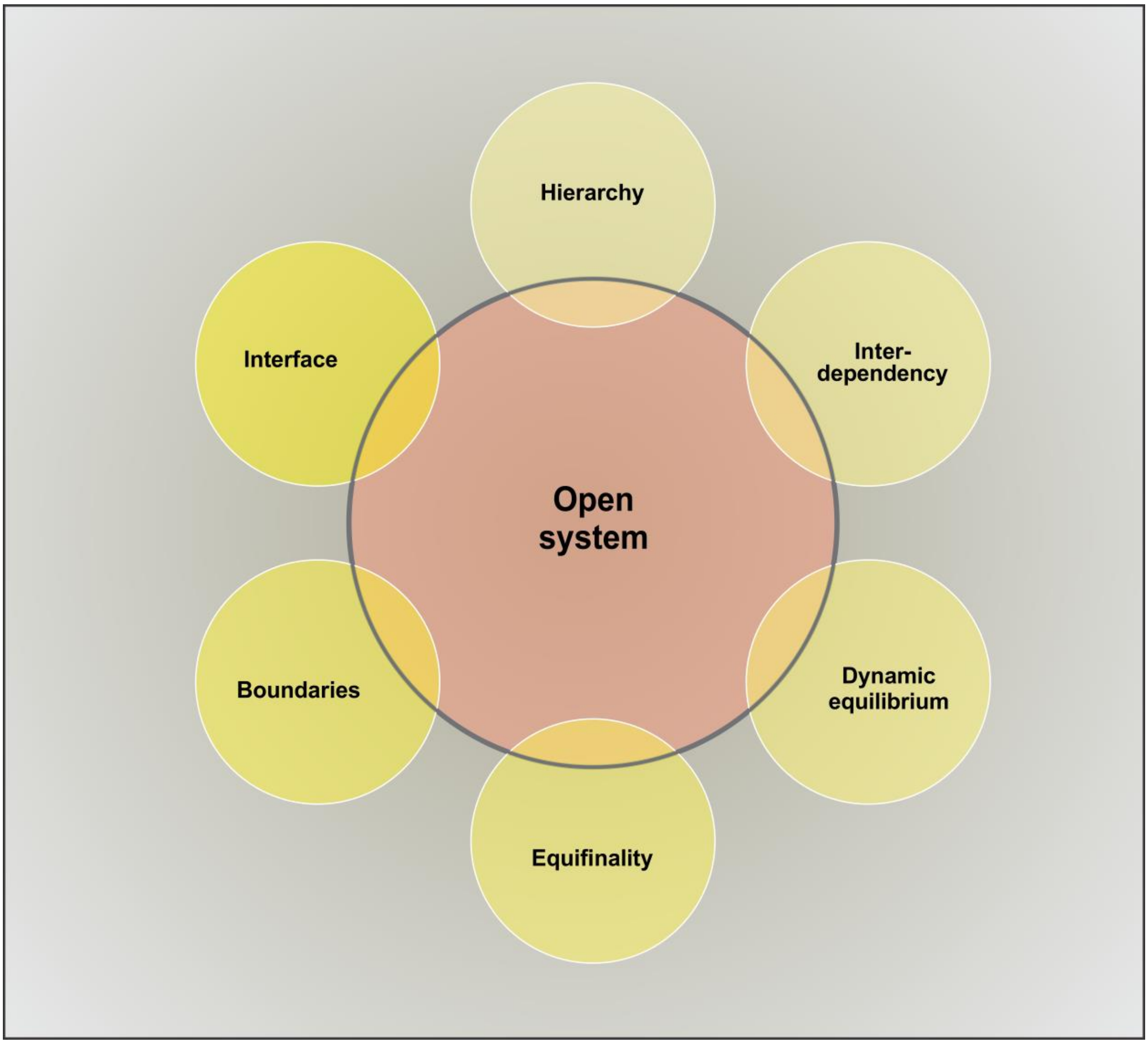


FIGURE 2.4: CHARACTERISTICS OF A FOOD SERVICE OPERATION AS AN OPEN SYSTEM

2.2.4.1 Interdependency

The food service system comprises diverse, interconnected parts or subsystems that are interdependent (Jagustovic *et al*., 2019). This implies that parts of the system have a reciprocal relationship and mutually affect the performance of each other (Gregoire, 2013:3). In the context of this study, different subsystems may have affected each other in a way that resulted in food waste generation or its prevention. For example, in a food service system the decision to offer a buffet meal may impact on food waste generation at the production-, service- and consumption subsystems. Similarly, the supply of substandard food ingredients (procurement subsystem) may cause food wastage at the storage-, production-, service- and consumption subsystems. According to Gregoire (2013:3), the interaction among the units of a food service organisation is implied by interdependency. For example, for an organisation to function effectively, the procurement division should interact with the production division. For instance, the procurement division may keep record of the stock available and interact with the production division. This will enable the menu and food production plan to be based on the stock available, so that food waste in the storage subsystem is prevented. Such an effective interaction results in *integration.* This enables the subsystems to work together to prevent food waste. The collective efforts of the individual parts may lead to a greater impact in total food waste prevention – *synergy*.

- ***Synergy***

The term synergy is derived from the Greek word ‘*synergos*’ which means ‘working together’ (Someh & Shanks, 2015). The concept of synergy, therefore, refers to the combined effect of two or more parts of a system working together to produce greater outcomes than the aggregate effect of the individual parts (Fan & Fang, 2019). As highlighted above, for synergy to be achieved, there is a need to consider all components and linkages of the entire food service system. Since a system is oriented towards an objective, any interaction among components must be designed to achieve that objective (Mockler, 1968). Even though the synergy effect is not mathematically formulated in this study, it was posited that the combined effects that arose from the interactions among the various parts of the system, may lead to greater food waste reduction, if all parts of the system worked together (Corning, 2014).

2.2.4.2 Dynamic equilibrium

It is assumed that the dynamic nature of a system and its elements are continuously reviewed, given the response and adaptation to the external or internal factors that trigger change (Jagustovic *et al*., 2019; Kast & Rosenweig, 1972). Nothing is static due to the constant change and reaction to factors that alter the behaviour of each subsystem and the system. This allows the food service system to constantly change and evolve (Jagustovic *et al*., 2019). In this study, it was important to consider the dynamic nature of the food service system as changing internal and external factors in the environment may have contributed to food waste generation. The food service manager should therefore, continually assess internal and /or external factors that can trigger change and cause food waste in the system. To maintain a dynamic equilibrium, any necessary changes to such factors can be made.

2.2.4.3 Equifinality

Equifinality is the assumption that in open systems the same end state or similar output(s) may be reached by employing varying inputs or using different transformation processes (Leighninger, 1978). In this study, this meant different strategies or practices could be applied to prevent food waste (Figure 2.5), as equifinality allows a set of feasible and equally effective food waste prevention practices to be applied. This concept is clearly illustrated throughout the study, as different total quality management practices and sustainability practices are adopted to reach the desired end goal i.e., reduced food waste.

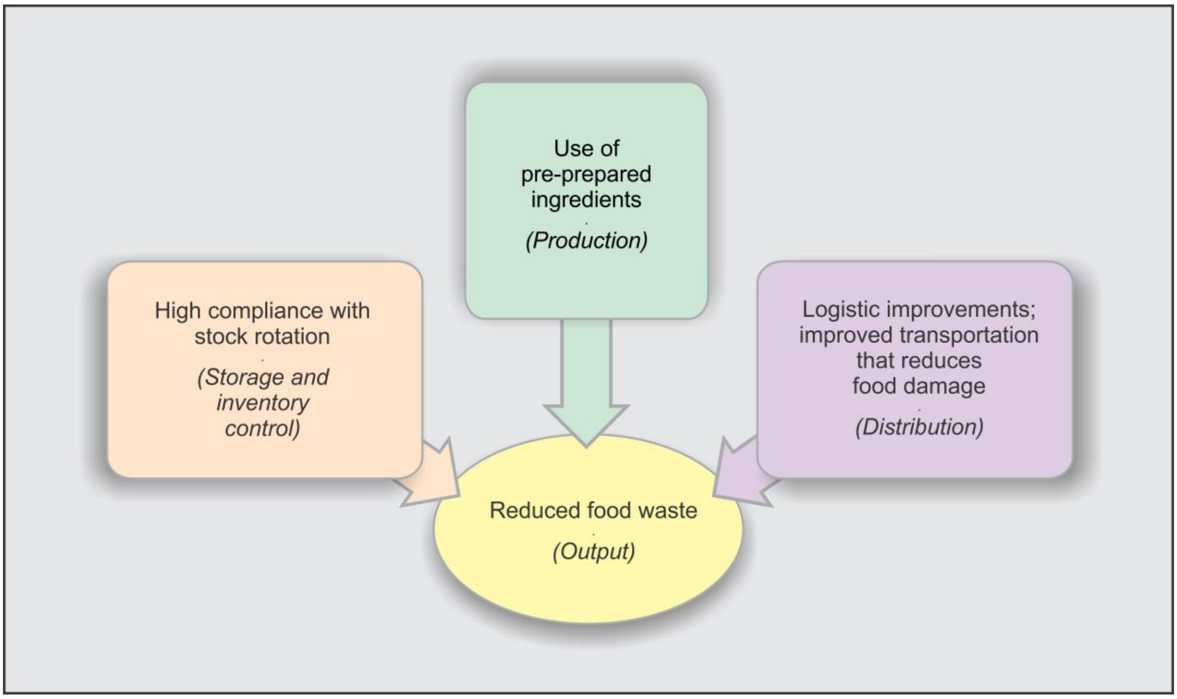


FIGURE 2.5: ILLUSTRATION OF EQUIFINALITY IN THE FOOD SERVICE SYSTEM

2.2.4.4 Permeability of boundaries

Permeability of boundaries is the degree to which boundaries of a system are open to external influences or integration (Kislov, 2018; Ringel *et al*., 2018). 'The intrusions of parts of one system into the operations of other systems speak to the permeability of system boundaries' (Glenn & Malott, 2004:4). Like other open systems, the boundaries of the food service system are permeable. Alterations in the environment external to the food service system may either contribute to or prevent food waste. For example, a change of food package material and size by the food manufacturer, changes of the delivery schedules by the supplier, unpredictable weather conditions, change of lecture times or university calendar events, are some of the external factors that may influence the food service system and contribute to food waste (Charlebois *et al*., 2015; Heikkila *et al*., 2016; Mena, Andeso-Diaz & Yurt, 2011). This study advanced different strategies that could be adopted to prevent food waste due to the permeability of the boundaries to the external environment. Delineating boundaries may help simplify the overwhelming complexity of the food service system. However, due to the complexity and unpredictability of the external environment, the researcher posits that food service managers need to continually assess the influence of the external environment on the system. The managers need to have measures in place to prevent food waste as a result of other possible external threats that may not have been established in this study.

2.2.4.5 Interface of systems and subsystems

The concept of interface is the area of interdependency or interrelationship between systems, subsystems or components (Gollnick, Stumpf, Scodruch & Lehner, 2011; Gregoire, 2013:4; Spears & Vaden, 1985:30). The interface of subsystems within the food service system is illustrated in Figure 2.6. Figure 2.7 further illustrates the interface of various subsystems in the functional subsystem. In this study the researcher argued that the interface of systems, subsystems and components was an important aspect that has implications on the generation of food waste. The overall food service system has numerous interfaces with external systems like suppliers, government agencies and regulatory bodies (Greigoire, 2013:4). Such external systems may contribute to food waste in the food service system, for example; delivery of substandard ingredients by suppliers may contribute to food waste in the food service unit. In the same way, rejection of substandard ingredients by the food service unit may generate food waste to the supplier. In organisations with central and satellite kitchens, for example, delivery of more than the required food at the satellites may lead to food waste at this level, while a last minute change of orders placed by satellite units may generate food waste for the central kitchen. At subsystem level, a classic example of interface is the management of any food surplus. The production subsystem and service subsystem frequently come in contact each other regarding a number of activities including food surplus management. Poor communication about food surplus between these two subsystems may contribute to food

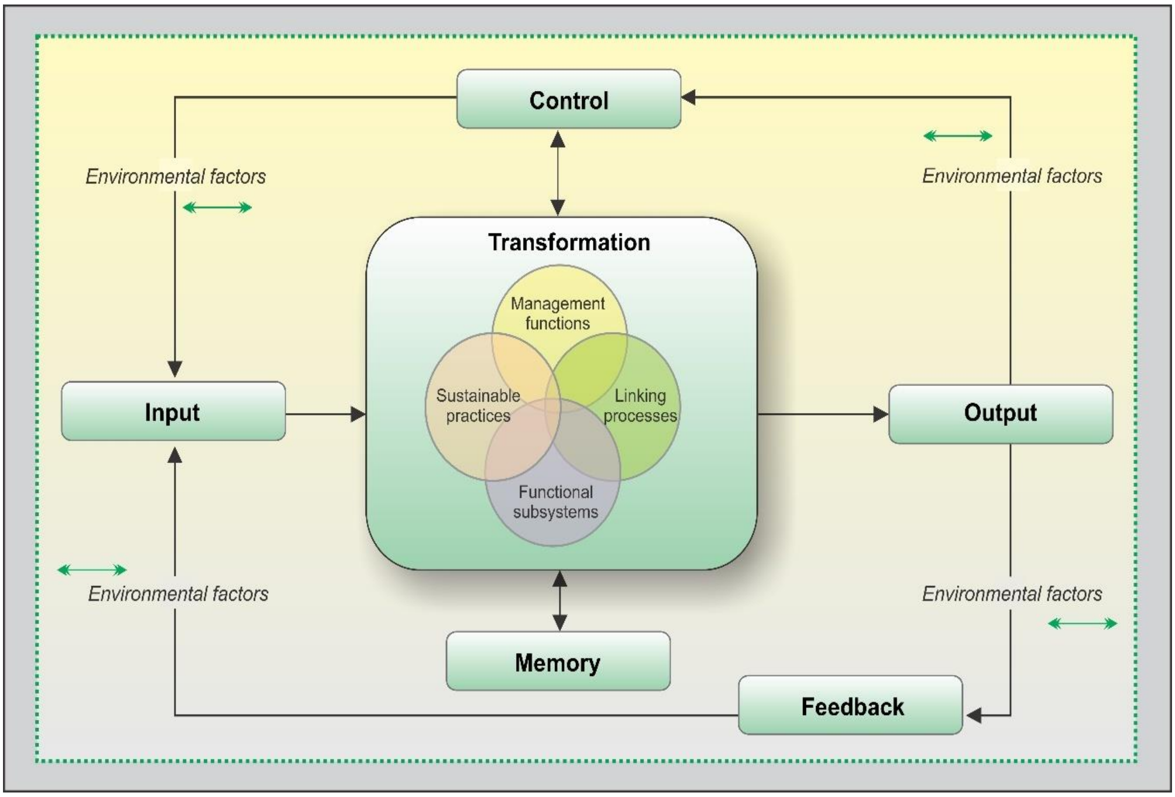


FIGURE 2.6: INTERFACES IN THE FOOD SERVICE SYSTEM (Adapted from Greigoire, 2013:5)

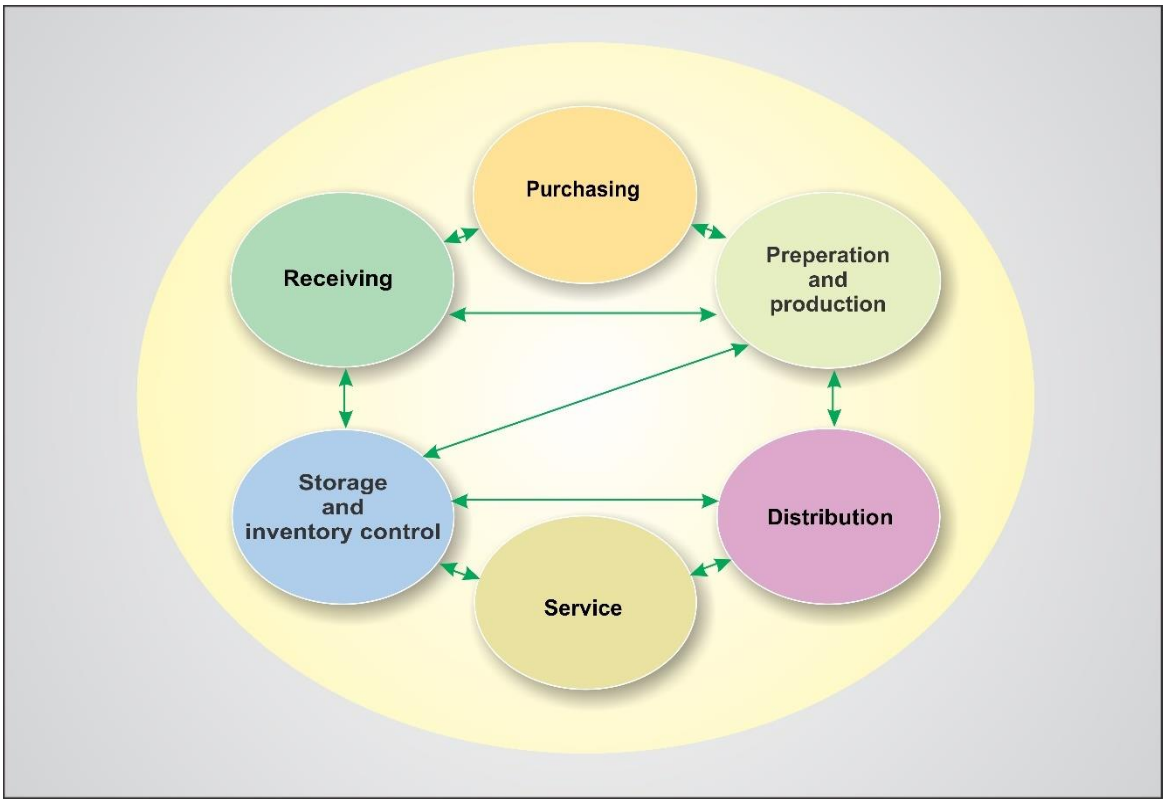


FIGURE 2.7: INTERFACES OF SUBSYSTEMS IN THE FUNCTIONAL SUBSYSTEM

waste. It is therefore, important to carefully analyse the interfaces between systems, subsystems and components, and assess their potential contribution to the generation of food waste. The necessary measures can then be advanced to address food waste that arises at such interfaces.

2.2.4.6 Hierarchy

Another basic characteristic in the food service system, is the hierarchical relationship between systems and subsystems. According to Kast and Rosenzweig (1972), the concept of hierarchy in the systems theory is the order of the system, its subsystems and components. Smith and Sage (1973) described the hierarchy as the decomposition of the system into subsystems thus forming a hierarchical structure. The description of the hierarchy depends on the system and the subsystems (Chen & Stroup, 1993). For this study, the hierarchy of the food service system is depicted in Figure 2.8, where the food service unit is viewed as a system within the larger system (or suprasystem) – the University. The food service system is composed of subsystems of different orders, for example, the transformation subsystem consists of different subsystems; management functions, functional subsystems and linking processes. These are further composed of another order of subsystems.

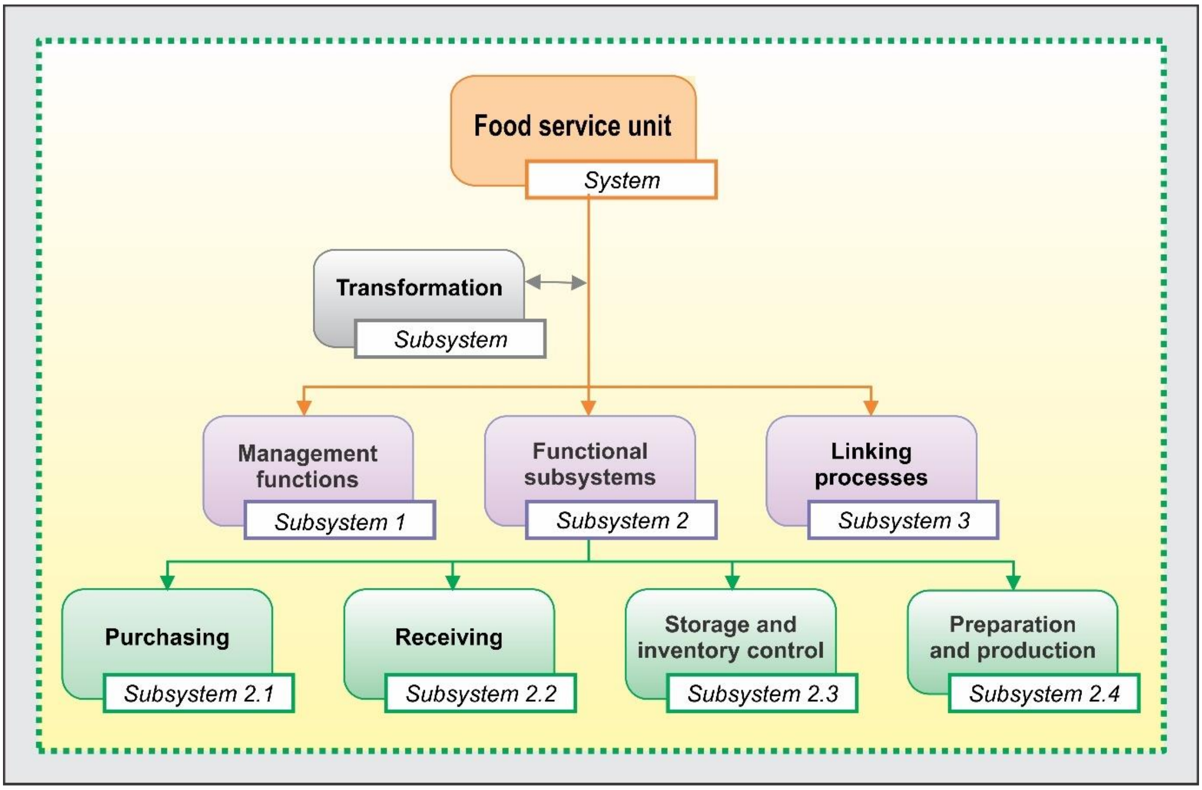


FIGURE 2.8: THE HIERARCHY OF THE FOOD SERVICE SYSTEM

2.2.5 Application of the systems theory in food service organisations

In this section, the systems theory is examined and its application in this study is discussed. As indicated above, the food service organisation is viewed as a system that comprises a set of interdependent and interrelated parts that work together to achieve a common goal and facilitate problem solving (Goonan *et al*., 2015). The problem that was addressed in this study was food waste and its prevention. To achieve this, a food service systems model was applied as shown in Figure 2.9.

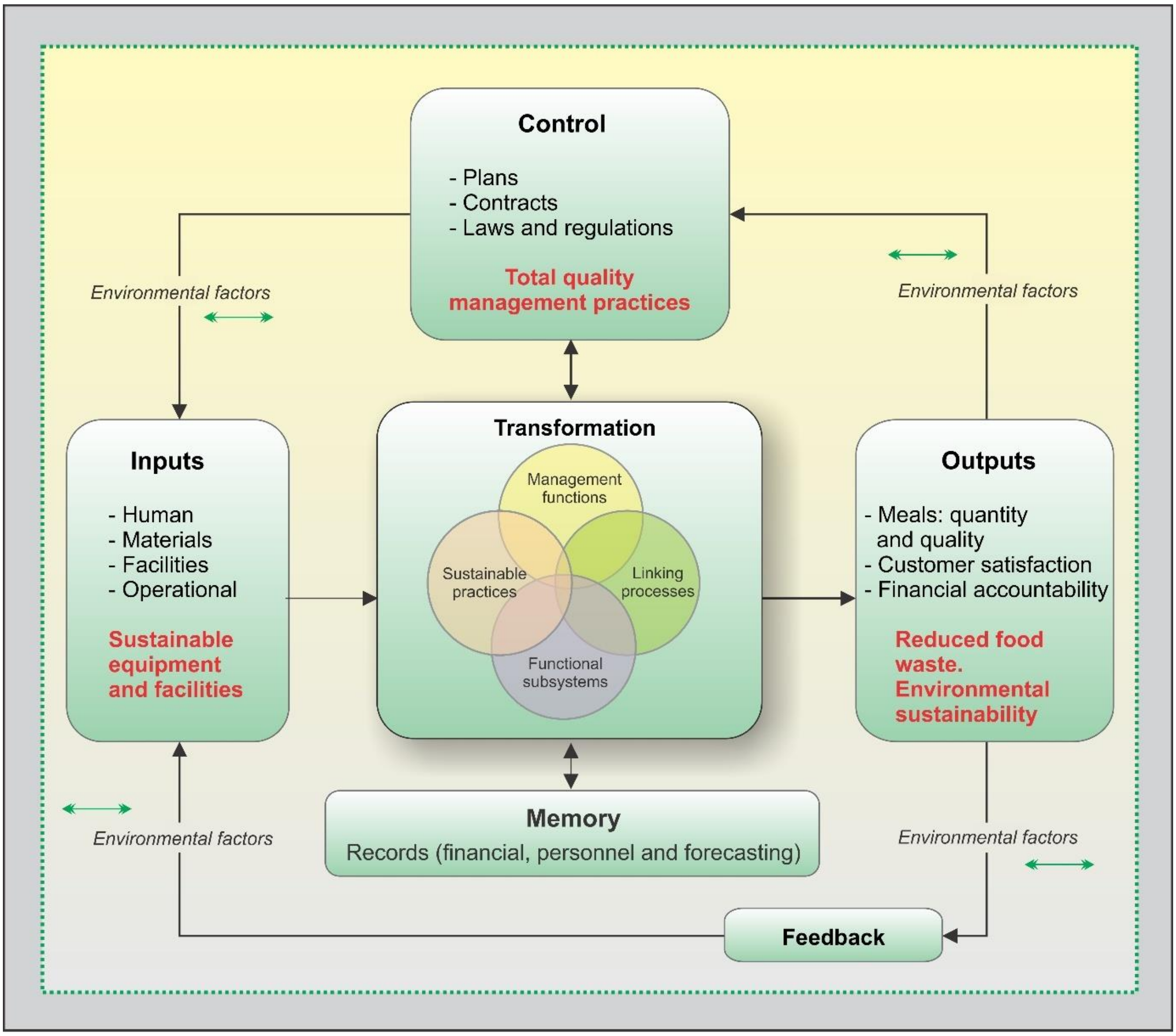


FIGURE 2.9: THE FOOD SERVICE SYSTEMS MODEL (Adapted from Gregoire, 2013:5; Payne-Palacio & Theis, 2016:61; Spears & Vaden, 1985:32)

The model includes inputs, which are transformed into outputs through operations in the transformation subsystem. During this transformation, inputs used and practices adopted to transform inputs into outputs, as well as the final outputs in the food service system may impact food waste generation or prevention. Furthermore, the functions of control, management and memory impact the transformation process and may have an influence on food wastage (Goonan *et al*., 2015). All subsystems interact with the external environmental factors in ways that can either prevent food waste or generate it (Goonan *et al*., 2015). For the managers, feedback from any part of the system provides useful information about corrective measures to prevent food waste (Goonan *et al*., 2015; Greigore, 2013:8; Payne-Palacio & Theis, 2016:61). Sustainable practices that may prevent food waste and ensure ecologically sound environmnents in the food service system, are embedded in the inputs and transformation subsystems.

2.2.6 Subsystems of the systems model

The following section elaborates on each of the subsystems of the food service system and how they were applied in the study.

2.2.6.1 Inputs

The food service system is fundamentally dependent on inputs, which are processed or transformed to produce outputs (Figure 2.10). Inputs are resources fed into the system to initiate change and produce outputs (Chen & Stroup, 1993; Drack & Schwarz, 2010).

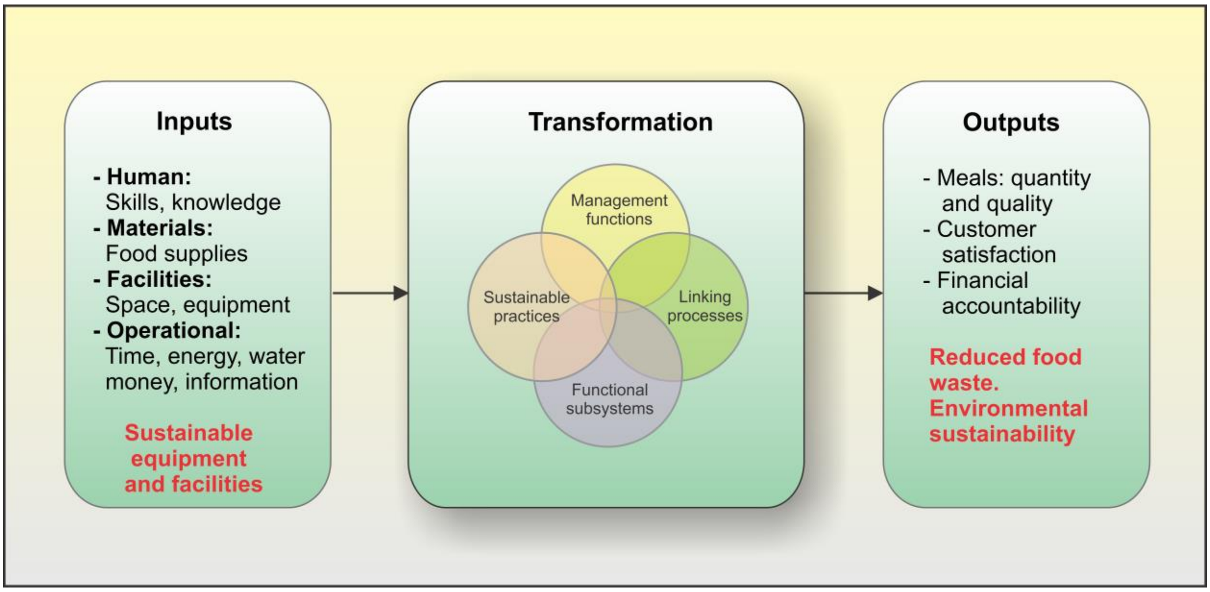


FIGURE 2.10: INPUTS IN THE OPEN SYSTEMS MODEL OF A FOOD SERVICE ORGANISATION (Adapted from Gregoire, 2013:2; Spears & Vaden, 1985:26)

In this study inputs were required indirectly or directly to produce outputs (Fan & Fang, 2019; Jugostovic *et al*., 2019; Ringel *et al*., 2018). The study further incorporated sustainable inputs into the system. The role of inputs in food waste generation or its prevention, are discussed in the next chapter.

2.2.6.2 Transformation

In the transformation subsystem, processes and activities are performed in order to convert inputs into finished goods and services or achievable goals (Amissah *et al*., 2015; Ramosaj & Berisha, 2014). The transformation element comprises the functional subsystems, management functions, and linking processes of the food service operation (Payne-Palacio & Theis, 2016:61-62). In this study, the additional component of sustainable practices was integrated into the transformation subsystem. This is a critical stage where the quantifiable food waste is generated as a result of poor practices and processes, during the transformation of inputs into outputs. However, some practices or processes at this stage can help reduce or prevent food waste. In the following subsection, the subsystems of the transformation are discussed in further detail. An analysis of how each of these subsystems contribute to food waste generation or its prevention is covered in-depth in subsequent chapters.

- *Functional subsystems*

In this study, a model of the functional subsystems was developed, which took into consideration the numerous operational activities conducted at the food service unit (Figure 2.11 – next page) (Baldwin, Wilberforce & Kapur, 2011).

⇒ *Procurement*

Procurement is the process of acquiring the necessary resources for the operation of the food service organisation (Baldwin *et al*., 2011). For this study, procurement was defined as the acquisition of materials needed for production and service in the food service organisation. Procurement in the food service system involves several actions as shown in Figure 2.12 (next page). The literature indicates that the manner in which procurement is conducted in a food service system may either contribute to the generation of food waste or prevent it (Charlebois *et al*., 2015; Heikkilä *et al*., 2016; Hennchen, 2019; Pirani & Arafat, 2014). This is discussed in Chapter Three (3).

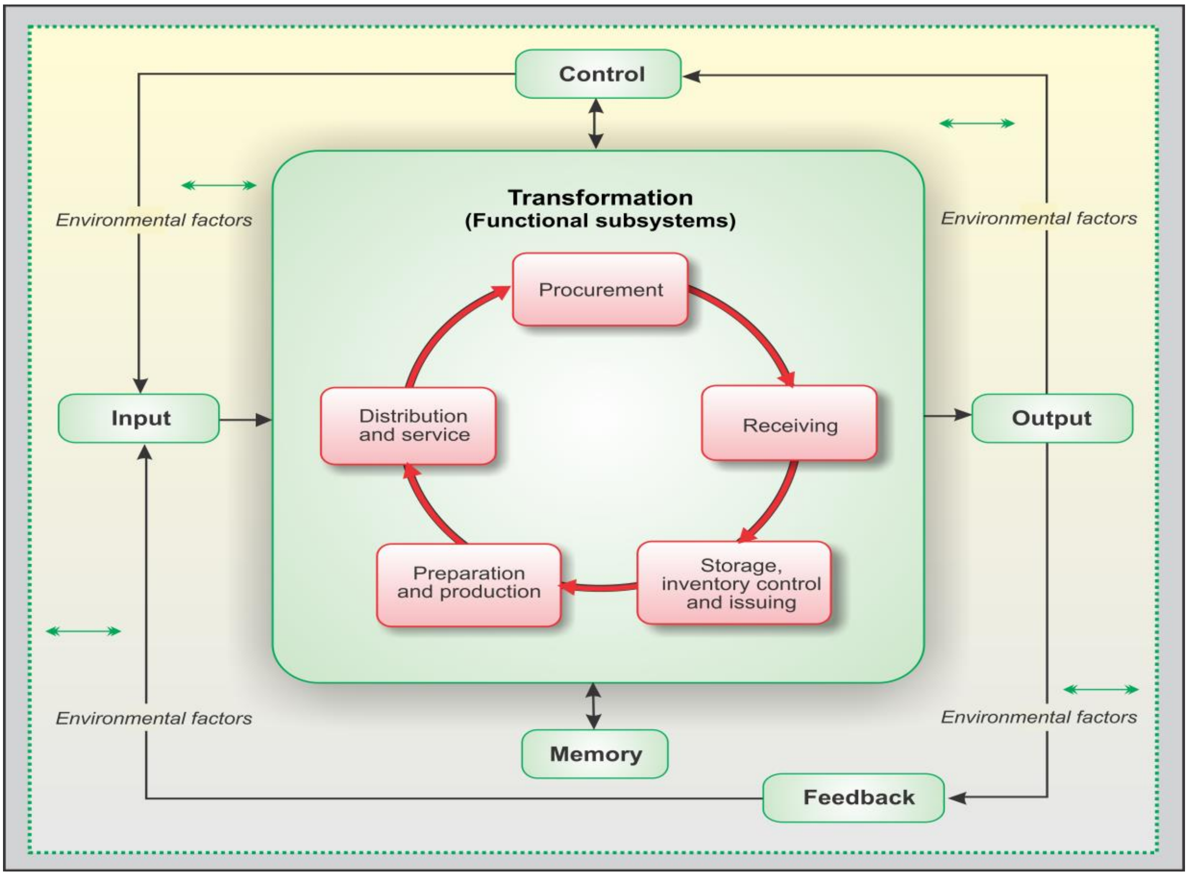


FIGURE 2.11: FUNCTIONAL SUBSYSTEMS OF A FOOD SERVICE SYSTEM (Adapted from Spears & Vaden, 1985:33)

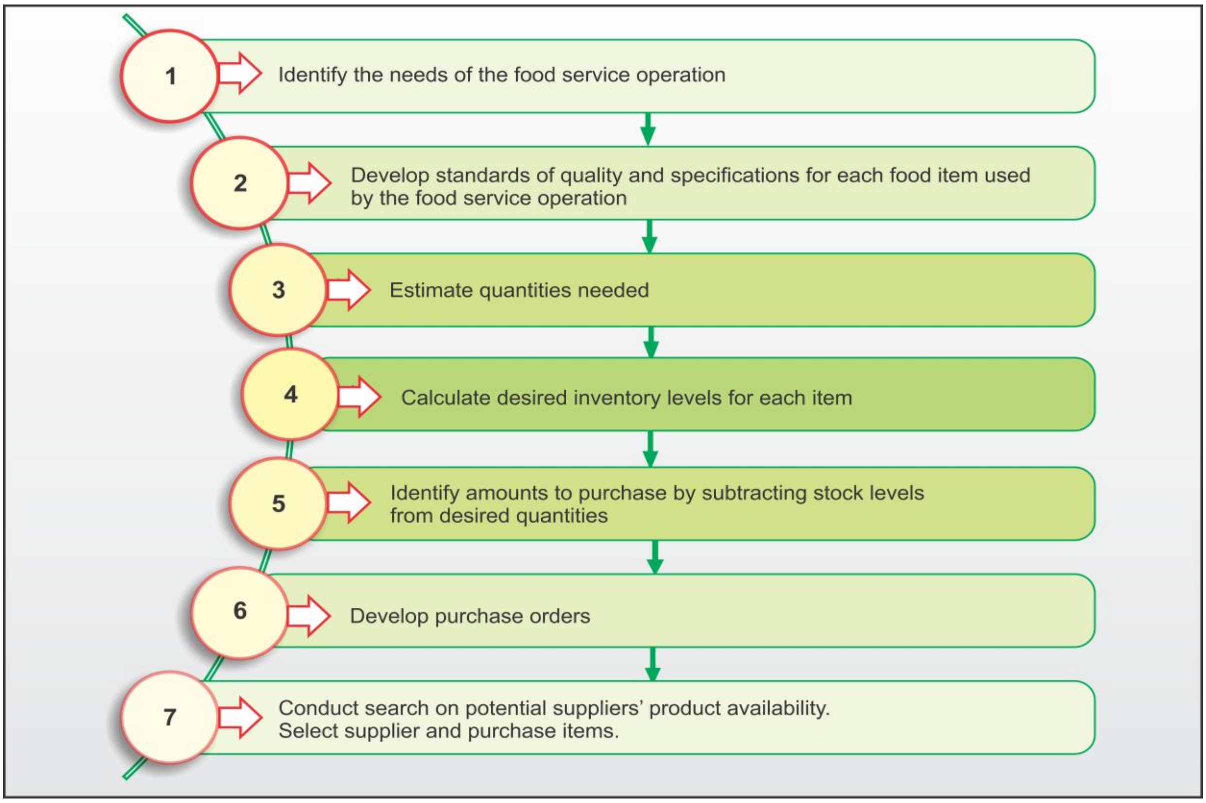


FIGURE 2.12: ACTIVITIES IN THE PROCUREMENT SUBSYSTEM (Adapted from Payne-Palacio & Theis**,** 2016:169)

⇒ *Receiving*

According to Payne-Palacio and Theis (2016:202), receiving is when the food service operation assumes legal ownership and physical possession of the items ordered. It is a function of the food service system that ensures that the food supplies received are according to the order, and conform to the stipulated specifications of quantity, quality and food safety criteria (Atia & Abdelgawad, 2016). A well-designed receiving programme is important in food quality control, reduction of food deterioration and prevention of food waste (Creedon, Cunningham, Hogan & O'Leary, 2010; Engström & Carlsson-Kanyama, 2004). A detailed discussion on how the receiving function contributes to food waste generation and/or its prevention is given in subsequent chapters. Tasks conducted within the receiving function are represented in Figure 2.13.

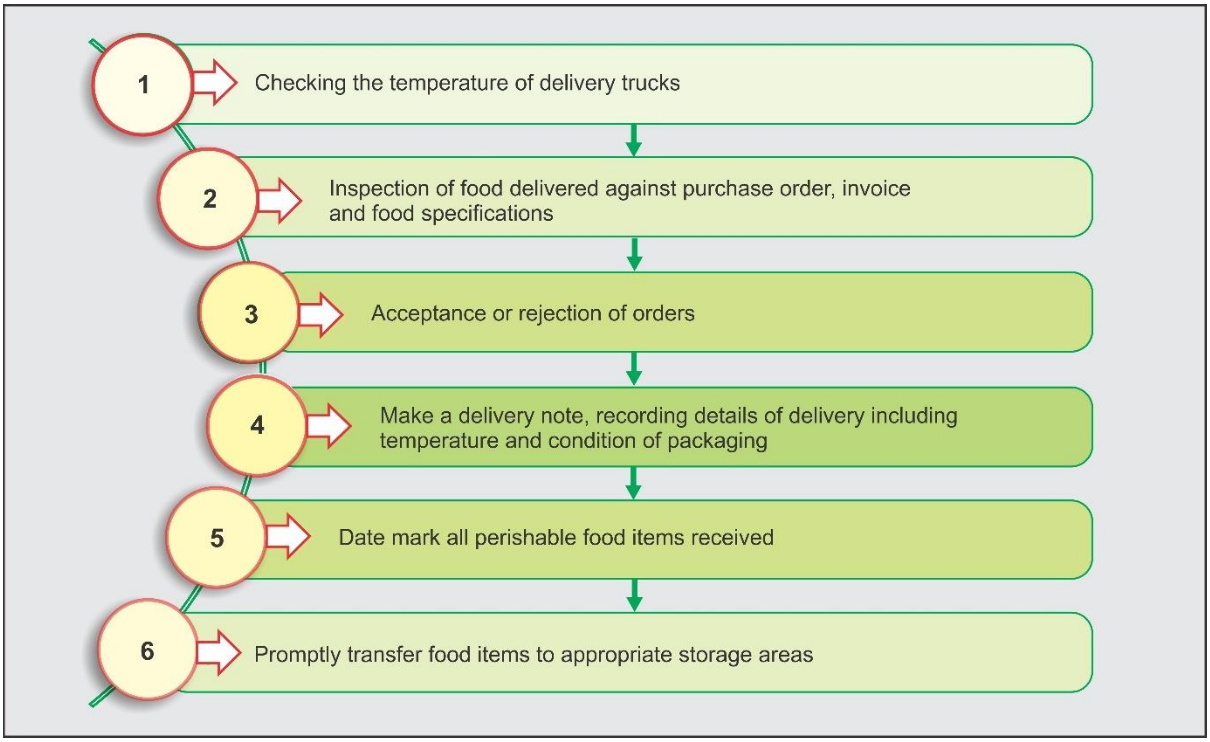


FIGURE 2.13: ACTIVITIES PERFORMED WITHIN THE RECEIVING FUNCTION (Adapted from Payne-Palacio & Theis, 2016:204; Spears & Vaden, 1985:189; Sullivan & Atlas, 1998)

⇒ *Storage, inventory control and issuing*

Storage, inventory control and issuing are important food service activities that ensure food supplies meet predetermined quality standards, and are held under conditions that preserve their quality before being issued for production and service (Payne-Palacio & Theis, 2016:214).

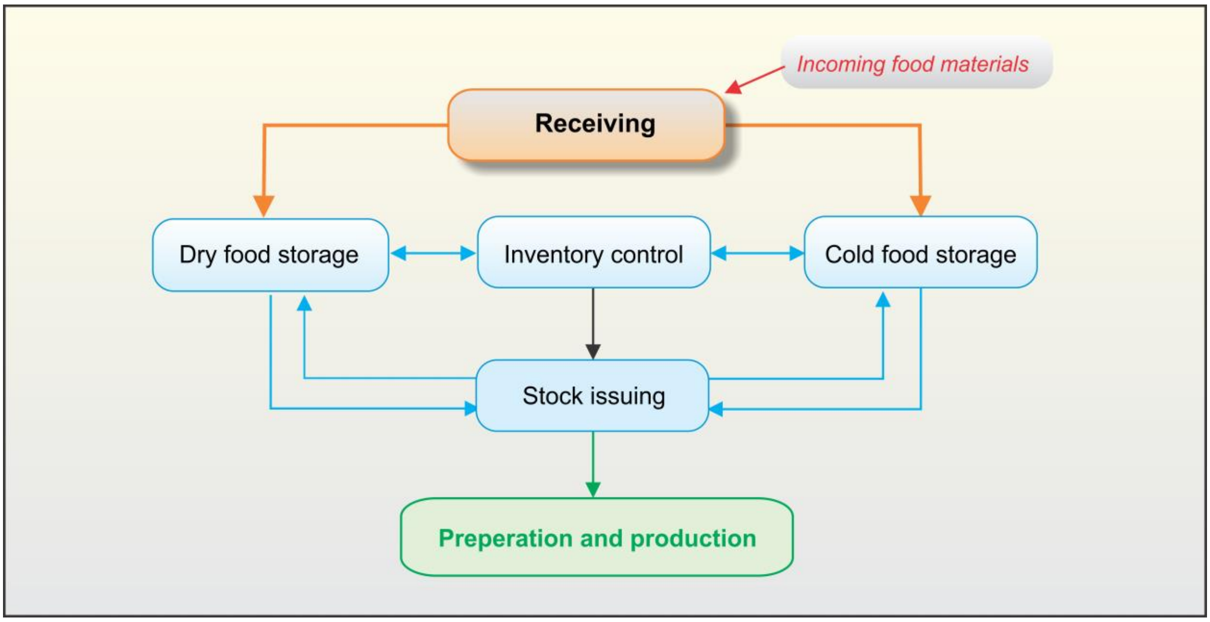


FIGURE 2.14: FOOD FLOW CHART OF THE STORAGE, INVENTORY CONTROL AND ISSUING FUNCTION

This clearly indicates that this function has important implications for food waste. The food flow through storage, inventory control and issuing is shown in Figure 2.14. Once the food is received at the food service unit it is transferred to either the dry- or cold food storage area (Ahmed *et al*., 2015). Inventory control measures are required for storage and issuing to ensure an accurate record of items in stock, and to minimise the risk of food deterioration. A requisition form of the list of supplies required by the production unit is compiled by the chef or production supervisor. It is then submitted to the storeroom clerk, who measures and weighs the requisitioned materials. An issue form is completed and the materials are provided to the appropriate workstation for preparation and production.

Storage is the holding of food products under the correct conditions to ensure quality until the time of use (Gregoire, 2013:130). During storage, stock management and stock control are critical, which have implications for food waste (Derqui, Fayos & Fernandez, 2016). According to Charlebois *et al.* (2015), adequate and proper storage of food is an important factor in the prevention of food waste. The correct temperatures and ventilation, storage space, and the arrangement, sanitation, and maintenance of the storage equipment are important to prevent food waste (Betz, Buchli, Göbel & Müller, 2015; Creedon *et al*., 2010; Derqui *et al*., 2016; Papargyropoulou *et al*., 2016).

Inventory control can be described as the monitoring and recording of food materials in stock (Gregoire, 2013:136). Practices that control inventory have a bearing on food wastage. According to Creedon *et al.* (2010), food waste can be prevented when stock rotation and the accuracy of recording stock comply with important aspects, such as the correct procedures in the food service system. Issuing is the process of releasing food or other supplies from the storage area to the production units and food service outlets (Ahmed *et al*., 2015). The process of issuing has implications on the generation of food waste and its prevention. Effective issuing practices such as compliance with the First-In-First-Out (FIFO) approach, as well as issuing accurate quantities of the correct products for production has a role in the minimisation of food waste (Kinasz *et al*., 2015).

⇒ *Preparation and production*

Preparation and production involve the conversion of ingredients to final menu items in the required quantities and desired quality (Ahmed *et al*., 2015; Gregoire, 2013:152; Payne-Palacio & Theis, 2016:217). Research has demonstrated that the level of food waste generated or reduced, differs with the food production system adopted by the food service operation (Ahmed *et al*., 2015; Edwards & Hartwell, 2006). Since the mid-1970s a number of food production systems have been introduced (Edwards & Hartwell, 2006), such as the **conventional** system (cook-serve), ready-prepared (cook-chill or cook-freeze), commissary, and assembly-serve systems (Payne-Palacio & Theis, 2016:63-67). A detailed account of how food production systems influence food waste will be given in subsequent chapters. The following diagram (Figure 2.15) illustrates typical activities carried out within the function of preparation and production.

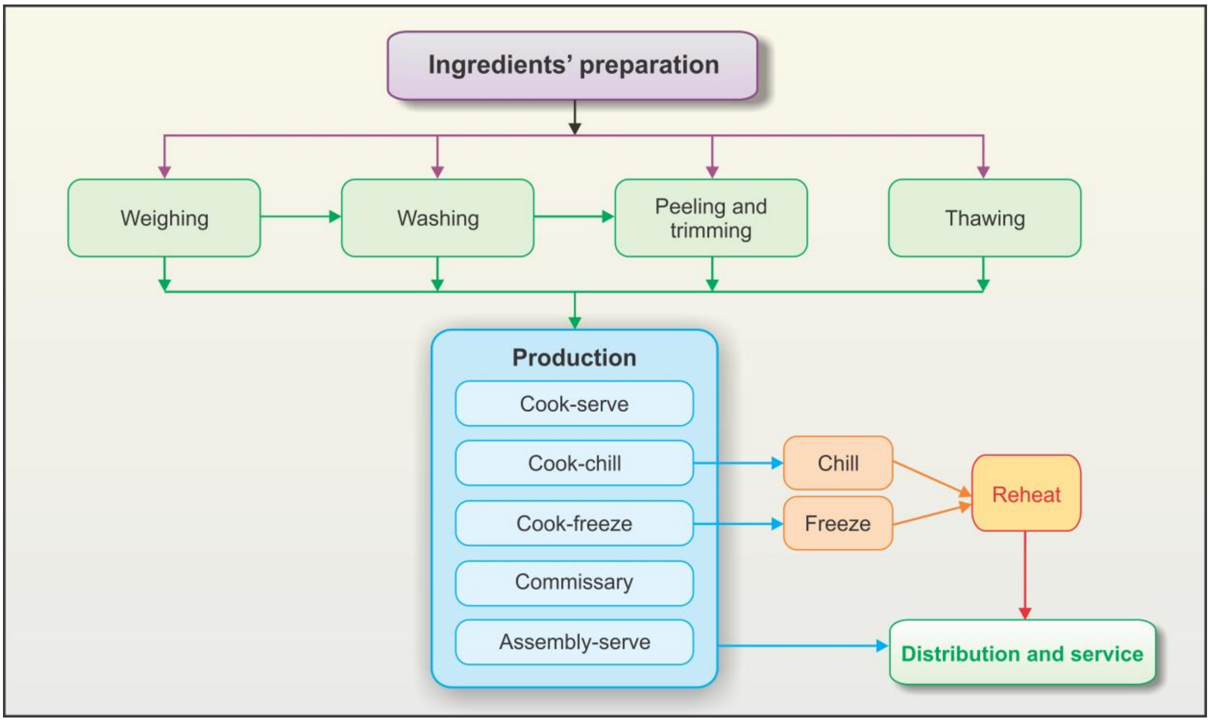


FIGURE 2.15: ACTIVITIES PERFORMED DURING THE PREPARATION AND PRODUCTION FUNCTION (Adapted from Ahmed *et al*., 2015)

⇒ *Distribution and service*

Distribution in the food service system refers to the movement of prepared food from production to the service point (Gregoire, 2013:206). Service is defined as the presentation of prepared food to the consumer (Davis *et al*., 2008:202). The activities conducted during the distribution and service function depend on whether the delivery system is centralised or decentralised. In a centralised delivery-service system meals are assembled onto trays or plates in the production area or central location before they are distributed to the service point to be served to customers, or, a decentralised delivery-service system where food is produced in one central location and distributed to various service units for assembly and service (Payne-Palacio & Theis, 2016:244). The distribution system adopted by a food service operation has implications on food waste generation or its prevention (Thyberg & Tonjes, 2016). The type of service, whether self-service or buffet service, tray service, wait service or the service of portable meals, has an influence on the generation of food waste or its prevention (Lam, 2010; Papargyropoulou *et al*., 2016). An in-depth discussion of the different types of distribution- and service systems, and how they can contribute to food waste reduction is detailed in Chapter 3.

- *Management functions*

Management functions, which are an integral part of the transformation subsystem, focus on the integration of resources by managers to accomplish the food service system's objectives (Gregoire, 2013:7). These include the functions of planning, organising, staffing, directing and controlling (Gregoire, 2013:7). The literature indicates that the management of the food service organisation influences the amount of food waste generated, since the management system affects how various activities and processes are conducted (Heikkilä *et al*., 2016). In this study, the management functions were integral to food waste management. A detailed discussion of the management functions and their linkage to food waste is presented in Chapter 3.

- *Linking processes*

The linking processes of decision making, communication and balance, are needed to coordinate the activities of the system toward the accomplishment of the food service organisation's goals (Spears & Vaden, 1985:31). These processes have an influence on food waste reduction. Decision-making, which is the process of selecting a course of action from a number of alternatives, has a bearing on food waste. Research shows that involving employees in decision-making, increases their responsibility in food waste reduction (Goonan *et al*., 2014). Another linking process, communication, which is the transfer of information between all levels of food service staff, departments, customers, suppliers and other stakeholders, or the lack of it, has an influence on the amount of food waste generated (Heikkilä *et al*., 2016). Research indicates that improved communication reduces food waste, for instance; understanding consumer expectations requires communication, and the reaction to consumer complaints and expectations helps reduce plate waste (Betz *et al*., 2015; Charlebois *et al*., 2015; Halloran, Clement, Kornum, Bucatariu & Magid, 2014). Balance, management's ability to maintain organisational stability under shifting conditions, has an influence on food waste. Balance can reduce or contribute to food waste, (Goonan *et al*., 2014). Chapter 3 includes further discussions on the linking processes in relation to food waste in the food service system.

2.2.6.3 Outputs

According to the literature (Jagustovic *et al*., 2019; Lai & Lin, 2017; Ringel *et al*., 2018), outputs are goods and services that result from processing and transforming inputs. Outputs vary within different organisations and usually include products, services, profits, satisfaction and the achievement of set goals (Chikere & Nwoka, 2015). In the context of food service organisations, outputs include: the desired quantity and quality of food, customer satisfaction, employee satisfaction and financial accountability (Gregoire, 2013:7). The concepts of the quantity and quality of food are important outputs in this study, as these can be directly related to food waste. Overproduction and poor food quality may generate food waste, while producing less food and of good quality, reduces food waste (Girotto, Alibardi & Cossu, 2015; Lam, 2010; Marais *et al*., 2017; Papargyropoulou *et al*., 2016; Williams & Walton, 2011). Customer satisfaction is another important output, which has implications for food waste. Research indicates that if the prepared food does not meet the expectations of the customers, plate waste may occur (Heikkilä *et al*., 2016). Financial accountability is another output applicable to this study. Food waste has cost implications associated with food production and the disposal of leftover food, therefore, reducing food waste lessens the financial burden (Goonan *et al*., 2014; Lundqvist, De Fraiture & Molden, 2008; Nahman, *et al*., 2012; Quested, Marsh, Stunnel & Parry, 2013; Whitehair *et al*., 2013). In this study, the additional outputs of reduced food waste and environmental sustainability are considered to be in line with the objectives of the study.

2.2.6.4 Controls

In the context of the food service system, controls are the external and internal plans and legal documents that affect and direct the way in which the organisation functions (Payne-Palacio

& Theis, 2016:61). The internal control element comprises the goals and objectives, standards, policies and procedures, and programmes of the food service organisation (Spears & Vaden, 1985:35). Internal controls can be linked to the generation of food waste and its prevention. For example, a study conducted by Goonan *et al*. (2014), indicated that internal controls such as stock monitoring and rotation policies, meal auditing, food safety plans, standardised recipes and portioning guidelines, contribute to the reduction of food waste. In the context of this study, another important internal control is the food waste policy. External controls of the food service system include contracts, government laws and regulations (Gregoire, 2013:8), which have an influence on food waste. External controls such as the food safety regulations that disallow the re-use of bulk food left over on any tray line, contribute to the generation of food waste (Goonan *et al*., 2014).

2.2.6.5 Memory

According to Spears and Vaden (1985:28), 'memory includes all the stored information and provides historical records of the system's operations'. Examples of such records include inventory records, financial records, forecasting, personnel records, meal statistics, recipes and menus (Spears & Vaden, 1985:36). In this study, another important set of records was the food waste tracking statistics. The literature clearly indicates that there is a link between the memory element and food waste in the food service system (Betz *et al*., 2015; Ferreira *et al*., 2013; Painter *et al*., 2016). For example, the use of automated forecasting systems, which enable food service operators to accurately predict the number of patrons to be served, helps avoid food surplus (Papargyropoulou *et al*., 2016). Subsequent chapters will further discuss how the memory element influences food waste in the food service system.

2.2.6.6 Feedback

The feedback subsystem provides information from the internal and external environment necessary for the food service operation to make adjustments in performance to achieve the set goals (Goonan *et al*., 2015; Jagustovic *et al*., 2019; Kast & Rosenzweig, 1972). If used, feedback assists with adjusting the system to the necessary changes, correcting the errors, maintaining a steady state or improving the system (Gregoire, 2013:3; Lai & Lin, 2017). The concept of feedback is important in this study, as it gives an understanding of how the system and its parts contribute to the generation of food waste or its prevention. This information provides management with the changes needed to reduce wastage. The element of feedback in relation to food waste is further discussed in Chapter Three (3).

2.2.6.7 Environmental factors

These are the internal and external forces that can impact the operation of the food service system (Goonan *et al*., 2015; Gregoire, 2013:3). Environmental forces may include social, economic, technological, demographic and political factors (Gregoire, 2013:3). To remain viable, the food service organisation must be responsive to environmental factors and maintain a dynamic equilibrium (Spears & Vaden, 1985:29). In the same way, for the food service organisation to prevent food waste, it has to be responsive to the changing environmental factors (Goonan *et al*., 2015; Priefer, Jörissen & Bräutigam, 2016). Chapter Three (3) provides a discussion on how environmental factors contribute to the generation and reduction of food waste.

2.2.7 Total quality management in the food service system

A total quality management programme is considered as an important component of the control subsystem (Figure 2.16). Total quality management is conceptualised as a programme with a set of practices that are applied to the functions and processes of the food service system to consistently meet customer expectations and quality standards of food products

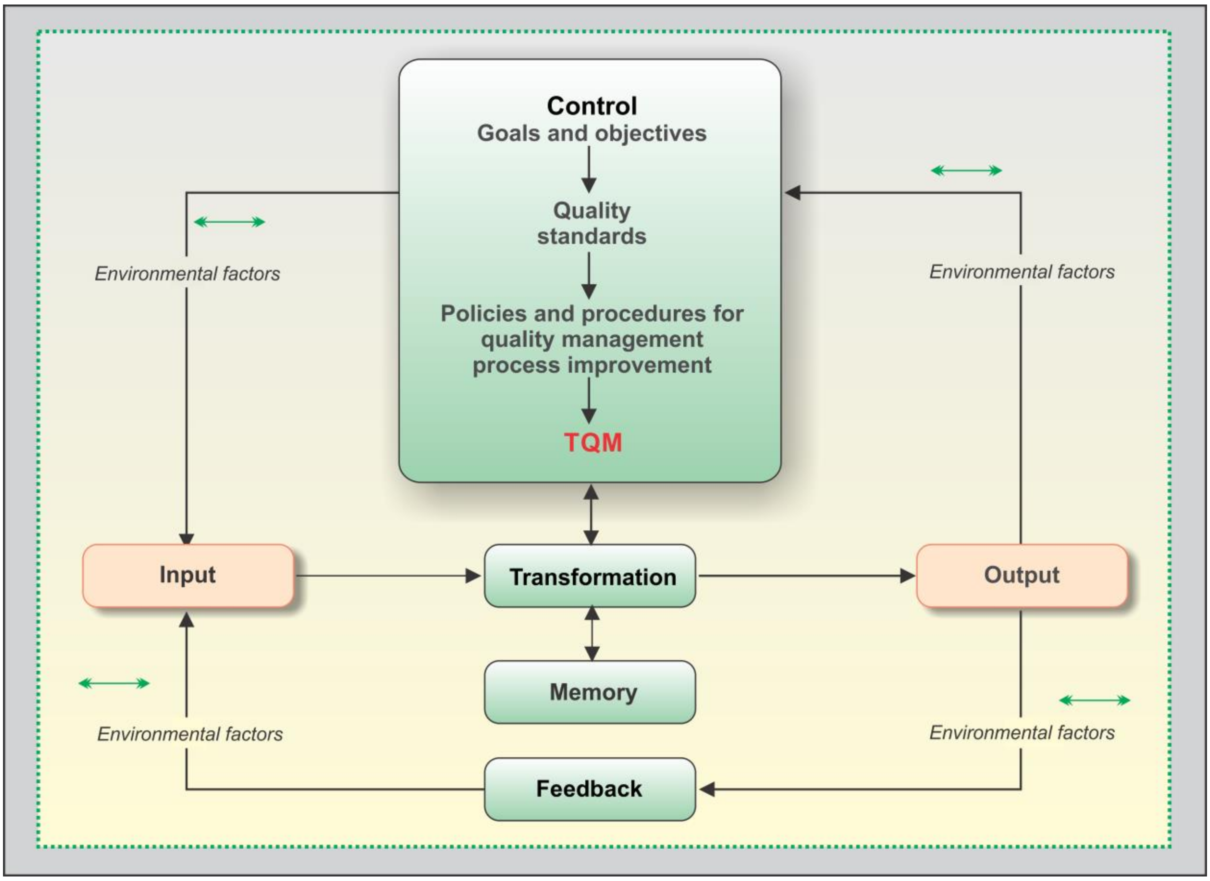


FIGURE 2.16: TOTAL QUALITY MANAGEMENT IN THE FOOD SERVICE SYSTEM (Gregoire, 2013:28)

and services (Jaca & Psomas, 2015). The concept of total quality management is discussed in Chapter 3. In a food service organisation, goals and objectives are the starting point for a total quality management programme (Gregoire, 2013:28). Organisational goals and objectives provide a basis for defining quality standards, which in turn are used to develop policies and procedures for quality management or process improvement (Gregoire, 2013:28).

2.2.8 Sustainability practices in the systems theory

Although there is increased attention on sustainability issues, there is no universal definition of the concept of sustainability, but several variations, which will be analysed in Chapter 3 (Pinard *et al*., 2007). For this study, sustainability was defined as those actions taken to ensure that the processes and activities in the food service system are carried out in a manner that use resources efficiently, minimise environmental harm and reduce food waste. As presented in Figure 2.17, the researcher theorises that the integration of sustainability practices in the food service system can be described as an input–output model, where the inputs used for transformation are sustainable practices with sustainably sourced ingredients, sustainable equipment and a sustainable kitchen environment. From a sustainable perspective, desired outputs in the food service system include reduced food waste and environmental sustainability or minimal harm to the environment.

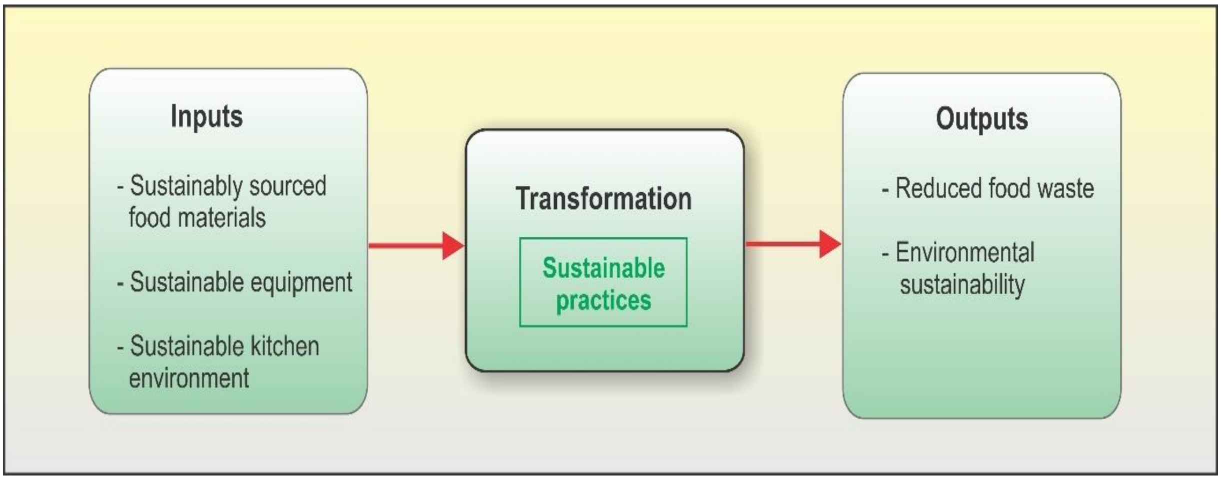


FIGURE 2.17: THE INPUT–OUTPUT MODEL OF SUSTAINABILITY IN THE FOOD SERVICE SYSTEM

2.3 THE FOOD WASTE HIERARCHY AS A FRAMEWORK FOR FOOD WASTE MANAGEMENT IN FOOD SERVICE OPERATIONS

In the next section, the food waste hierarchy is described in detail, its historical background is discussed and various food waste management options in the waste hierarchy are critically explained. The section further includes a discussion on how the food waste hierarchy was applied in this study.

2.3.1 What is the food waste hierarchy?

This study applied the food waste hierarchy (Figure 2.18) as a framework for food waste management in food service operations. The food waste hierarchy can be described as a waste management framework and a practical tool. This assists in identifying the most appropriate solution to food surplus and food waste for the sustainable management of waste (Papargyropoulou *et al*., 2014; Thyberg & Tonjes, 2015). The food waste hierarchy is commonly described as a priority order of different food waste management options, which are available, based on their assumed impact on the environment (Van Ewijk & Stegemann, 2016).

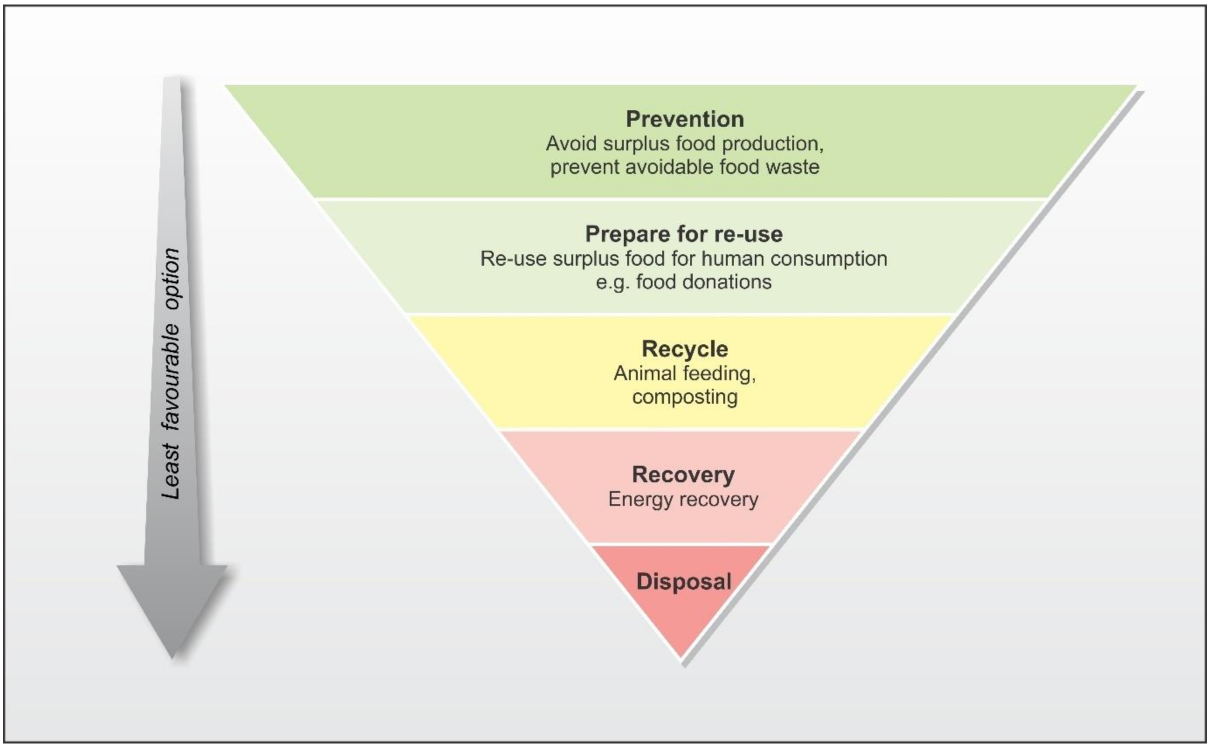


FIGURE 2.18: THE FOOD WASTE MANAGEMENT HIERARCHY (Papargyropoulou *et al*., 2014)

2.3.2 Historical background of the food waste hierarchy

A number of general waste management frameworks have been developed and applied since the 1970s (Eriksson, Strid & Hansson, 2015). 'Frameworks and concepts, such as: the waste hierarchy, the 3Rs (Reduce, Re-use, Recycle), 4Rs (Reduction, Re-use, Recycle, Recovery), zero waste hierarchy, extended producer responsibility and life cycle assessment (LCA) have been developed and used to manage waste' (Papargyropoulou *et al*., 2014:106). An increasing number of researchers and waste management practitioners address food waste via the concept of a hierarchy (Mourad, 2016). According to the literature, the waste hierarchy first came into law in 1975, following a Waste Framework Directive adopted by the European Commission (Filimonau & De Coteau, 2019; Mourad, 2016). However, this waste hierarchy (Figure 2.19) lacked specificity but provided general guidelines for all types of waste (Eriksson *et al.*, 2015).

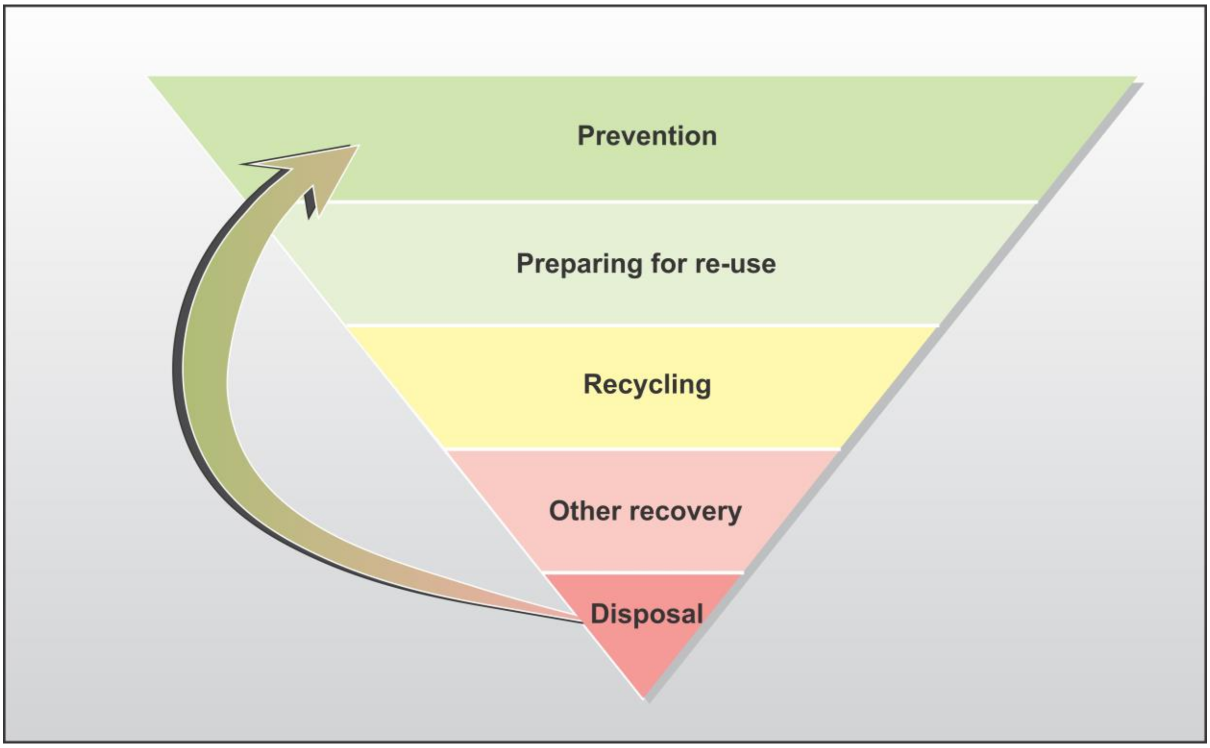


FIGURE 2.19 THE EU WASTE HIERARCHY (European Union, 2016)

Due to this limitation, researchers found it necessary to close the gap and develop waste management frameworks specific to food waste. The developed hierarchies have some commonalities, but different names and labels are used in different geographical locations (Filimonau & De Coteau, 2019).

In the United States, the waste hierarchy stems from the 1970s and originates from the prioritisation of waste prevention by the 3M Corporation and the state of North Carolina (Van Ewijk & Stegemann, 2016). In the 1980s, the California Office of Appropriate Technology developed a hierarchy for hazardous waste management, which was mentioned in a publication on alternatives to land disposal of hazardous waste (Van Ewijk & Stegemann, 2016). In 2014, the United States Environmental Protection Agency (U.S. EPA) developed a hierarchy specific to food waste, called a food recovery hierarchy (Figure 2.20). The US food recovery hierarchy agreed with the general principles of the EU waste hierarchy (Eriksson, 2015). However, an important distinction between the two hierarchies is that the US food recovery hierarchy further divided the prevention dimension into source reduction (the more preferred option) and feeding hungry people (less preferred) (Eriksson, 2015). This denotes the importance of reducing food production to prevent food wastage from occurring in the first place. A donation of food to hungry people can be limited by a number of internal and external forces such as food safety regulations.

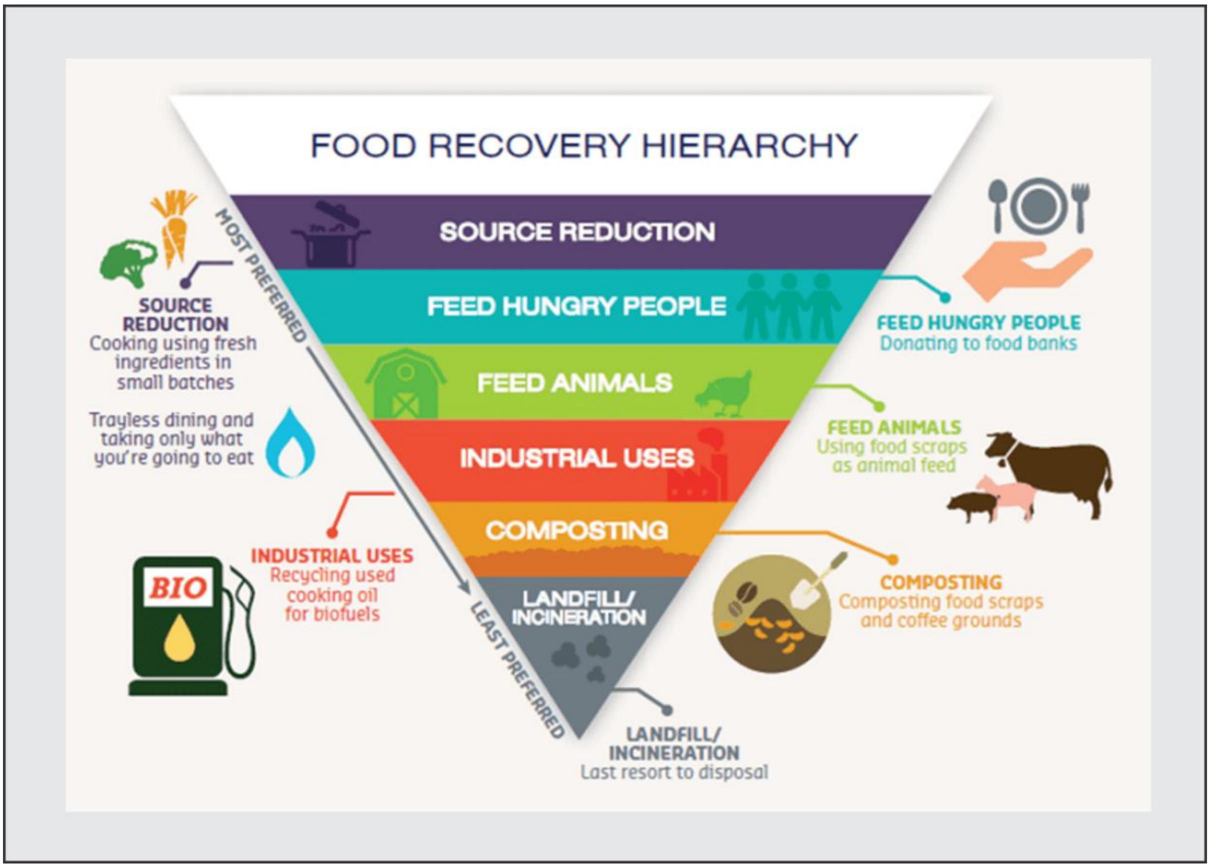


FIGURE 2.20: FOOD RECOVERY HIERARCHY IN THE UNITED STATES (U.S. EPA: 2014)

In the Netherlands, a food waste hierarchy called the Moerman's ladder (Figure 2.21) was developed from the more general Lansink's ladder, which was formulated by former scientist and Dutch politician, Ad Lansink, back in 1979 (Van Ewijk & Stegemann, 2016). From the literature, it is not clear as to when the Moerman's ladder was developed. Moerman's ladder has ten-tiers, making it different to other food waste hierarchies. The first level indicates the optimal use of food and total avoidance of food waste, and levels two to ten indicate how to deal with surplus food or food waste.

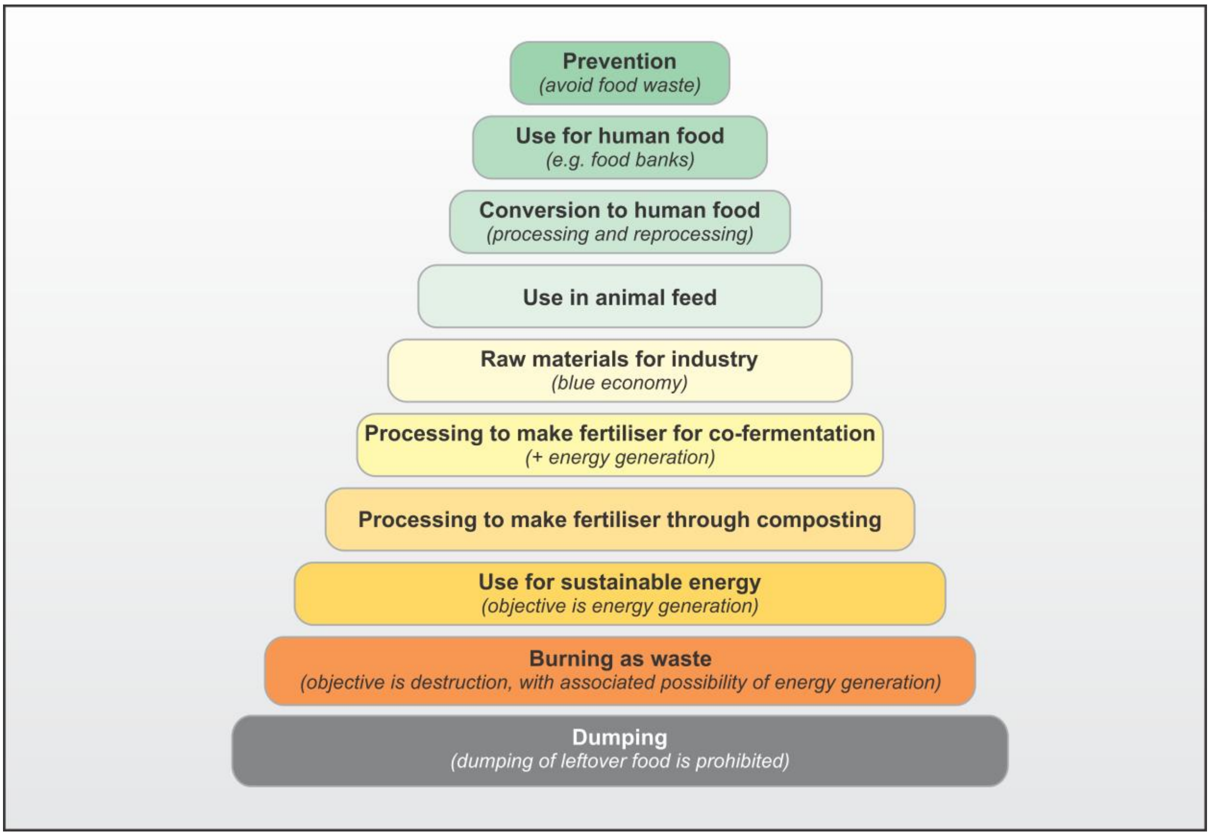


FIGURE 2.21: MOERMAN LADDER (FOOD WASTE MANAGEMENT HIERARCHY) IN THE NETHERLANDS
(Van Ewijk & Stegemann, 2016)

In the UK, the waste hierarchy has become law through the Waste (England and Wales) Regulations 2011 and the Waste (Scotland) Regulations (WRAP, 2019). For the easy application of the hierarchy in the food service sector, the Waste and Resources Action Programme (WRAP) developed a specific food and drink material hierarchy (Figure 2.22). This sets out prevention as the most preferable option followed by recycling, recovery and disposal (WRAP, 2019). The food and drink material hierarchy subdivides the prevention measure into three sub-levels: food waste reduction, redistribution to people and use in animal feeds (WRAP, 2019).

Various scholars in the hospitality and food service field applied specific food waste hierarchies. Papargyropoulou *et al.* (2014) examined factors that gave rise to food waste. They then proposed a framework to identify and prioritise the most appropriate options to prevent

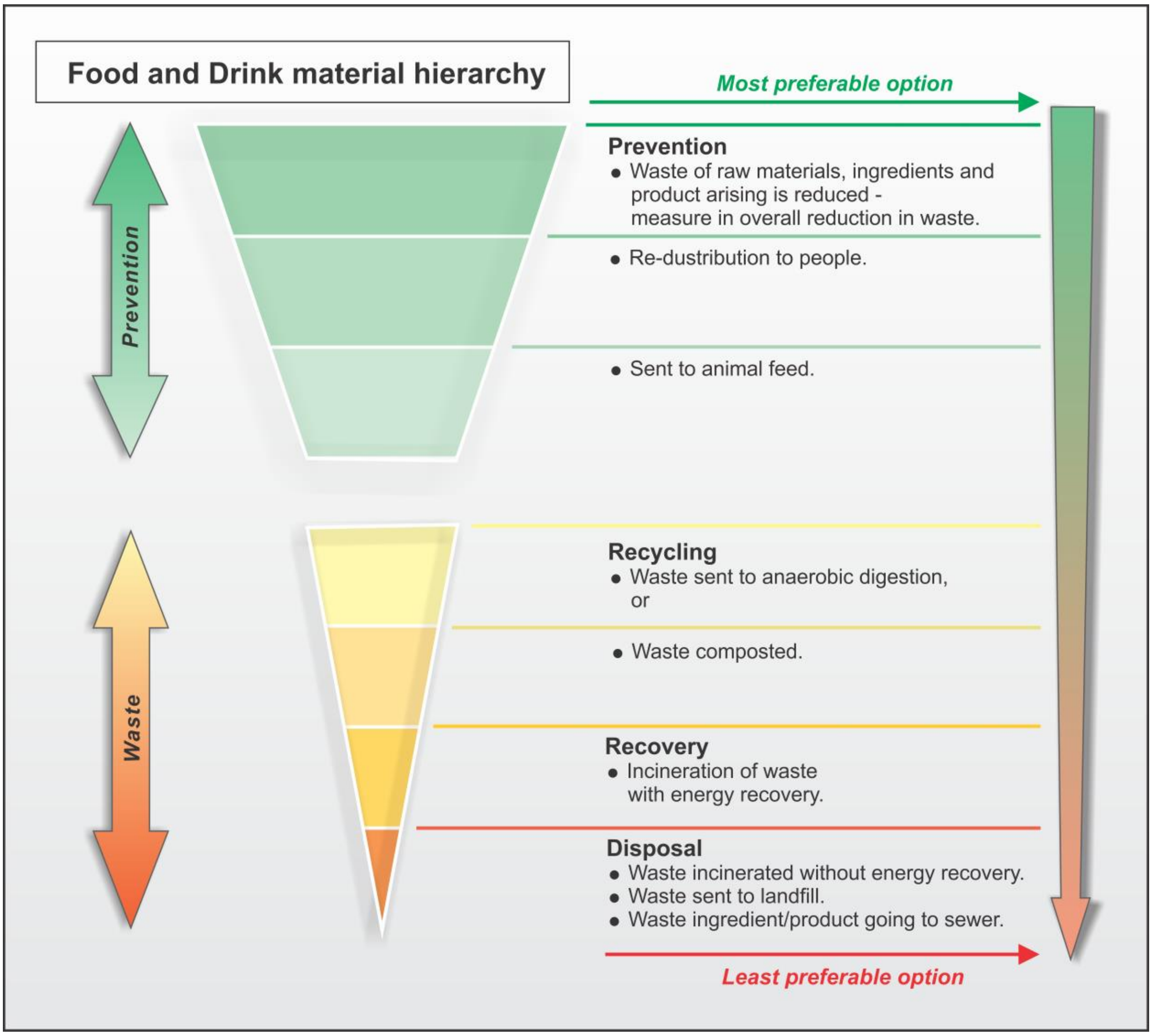


FIGURE 2.22: FOOD AND DRINK MATERIAL HIERARCHY IN THE UK (WRAP, 2019)

and manage food waste (Figure 2.18). Filimonau and De Coteau (2019) developed a hospitality food waste management hierarchy (Figure 2.23), which outlines the specific food waste prevention and management measures that can be adopted by managers in the specific area of hospitality operations. One important difference between the hospitality and other food waste management hierarchies is that it outlines key internal and external factors that can enable and inhibit successful adoption of food waste minimisation and management actions (Filimonau & De Coteau, 2019). However, the framework outlines limited actions across the hierarchy, despite the extensive evidence of practices that have been applied to successfully prevent and manage food waste.

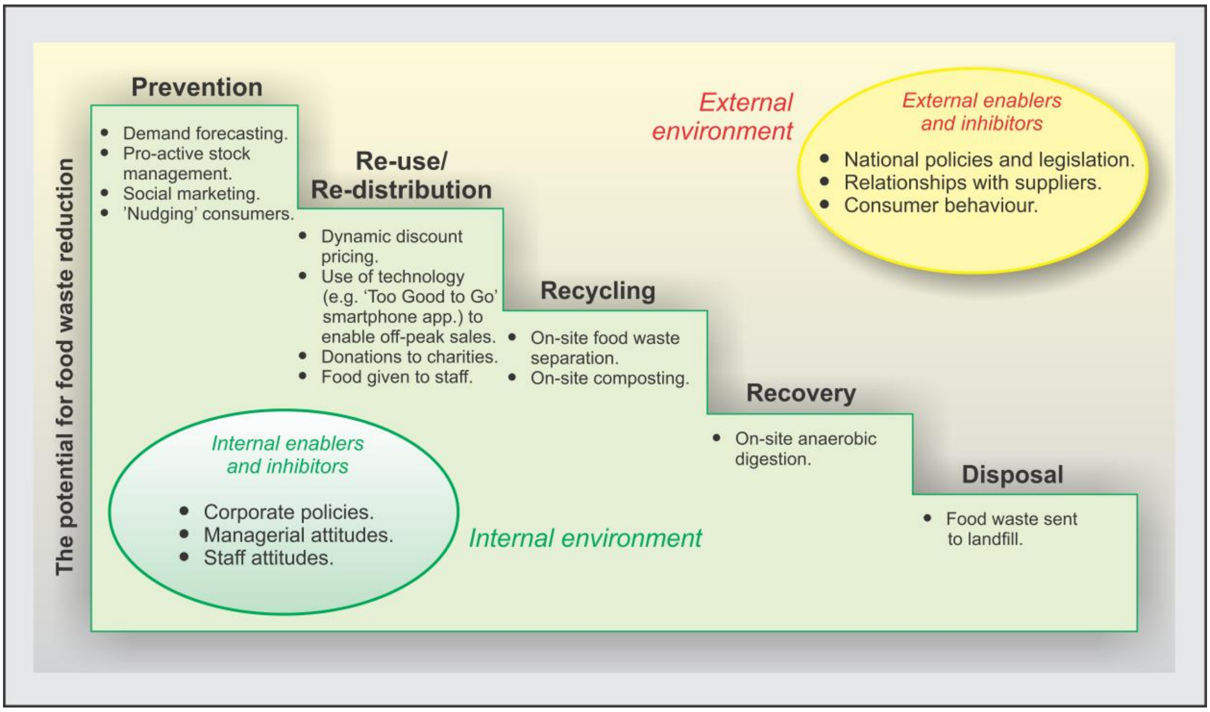


FIGURE 2.23: HOSPITALITY FOOD WASTE MANAGEMENT FRAMEWORK (Filimonau & De Coteau, 2019)

All the food waste hierarchies discussed above, have one commonality; the prioritisation of the prevention of food waste, since it is a more sustainable option with little harm to the environment. This study therefore, focused on the prevention of food waste as the most preferable option in food waste management (Eriksson *et al*., 2015).

2.3.3 An overview of food waste management options in the waste hierarchy

In the discussion above, it was mentioned that there are different food waste management options available across geographical locations and fields of study. This study used the five-tier formulation of the hierarchy formalised by the EU's 2008 Waste Framework Directive. In order of preference, the food waste hierarchy suggests prevention, re-use, recycle, recovery and disposal as waste management options. These will be further discussed in the following subsections.

2.3.3.1 Prevention

According to the literature, prevention of food waste (or source reduction) in the first place, represents the ideal and most preferred approach to food waste management (Garcia-Garcia, Woolley & Rahimifard, 2015; Mourad, 2016; Papargyropoulou *et al*., 2014; Priefer *et al*., 2016). A discussion of food waste prevention strategies is covered in the literature review and discussion chapters. The prevention of food waste benefits the environment and is the most sustainable food waste management option (Dou, Ferguson, Galligan, Kelly, Finn & Giegengack, 2016).

2.3.3.2 Re-use

Where there is unavoidable surplus food, the best option is to re-use it. The redistribution of surplus food suitable for human consumption to hungry people via networks and food banks, ensures food security for the impoverished population groups and conserves the environment (Garcia-Garcia *et al*., 2015; Papargyropoulou *et al*., 2014). Although the donation of excess food is an attractive option to reduce food waste, food safety standards and regulations can impede its implementation (Filimonau & De Coteau, 2019). For example, according to a study conducted by Bohdanowicz (2006), in Poland and Sweden only 32.3% and 17.4% respectively, of surplus food in the hospitality area is donated due to legal restrictions. This implies that most of the food that could be redistributed ends up being wasted.

2.3.3.3 Recycle

The food waste hierarchy indicates that where food waste cannot be prevented at the source and the surplus food cannot be redistributed, the next best option is recycling (Garcia-Garcia *et al*., 2015). Recycling refers to the diversion of wasted food from landfills to other beneficial non-human uses, including feeding animals and composting (Dou *et al*., 2016). While recycling food is a less preferable food waste management option, it is preferable to landfill disposal as it reduces costs and environmental impacts (Nahman *et al*., 2012). Recycling for the use of animal food is not always possible. Some regions, such as Europe, have strict laws such as the EU animal by-product regulations, which hampers food waste for animal feed (Eriksson *et al*., 2015; Filimonau & De Coteau, 2019). Additionally, food waste typically contains meat waste and if not heat-treated, can transmit diseases, such as foot-and-mouth and African swine fever to animals (Salemdeeb, Zu Ermgassen, Kim & Balmford 2017; Zhang, Su, Baeyens & Tan, 2014). Microorganisms decompose organic waste, including food waste, by using oxygen to produce a nutrient-dense soil conditioner called compost. This has environmental and economic benefits but it is not always possible in food service operations due to space constraints (Filimonau & De Coteau, 2019; Garcia-Garcia *et al*., 2015).

2.3.3.4 Recovery

Once recycling efforts are exhausted, treatment of food waste for recovery of energy through anaerobic digestion is the next preferred option (Papargyropoulou *et al*., 2014). 'Anaerobic digestion is a biological process in which organic waste is decomposed by naturally occurring bacteria in the absence of oxygen to obtain biogas, which can be used to generate fuel, heat or electricity' (Garcia-Garcia *et al*., 2015:68). Compared to traditional food waste management methods (that is; landfilling, incineration and composting), anaerobic digestion is environmentally friendly (Xu, Li, Ge, Yang & Li, 2018). The application of anaerobic digestion can however, be constrained by high operational costs, volatile fatty acid accumulation and process instability (Filimonau & De Coteau, 2019; Xu *et al*., 2018).

2.3.3.5 Disposal

The disposal of food waste is the least preferred management option. This involves sending food waste to landfills and incineration plants (Garcia-Garcia *et al*., 2015; Ren, Yu, Wu, Wang, Gao, Huang & Liu, 2018). 'Food waste disposal is associated with costs for waste disposal, the lack of land space, groundwater pollution by leachate, and the emission of toxic and greenhouse gases' (Ren *et al*., 2018:1069). Despite the negative social, environmental and economic costs associated with disposal of food waste, 90% of food waste ends up at landfills (Thi, Kumar & Lin, 2015). This is a clear indication that it is important for food waste researchers and practitioners to develop and validate tools to prevent food waste in food service operations.

2.3.4 Application of the food waste hierarchy in the current study

There is a growing concern about the current status of food waste management and leniency towards less preferred options of the waste hierarchy in the hospitality industry (including food service operations), which may lead to a significant increase in the environmental footprint (Pirani & Arafat, 2016). 'The food waste hierarchy clearly indicates that prevention, through minimisation of food surplus and avoidable food waste, is the most attractive option' (Papargyropoulou *et al*., 2014:106). However, a few empirical studies developed tools and strategies to prevent food waste in the food service area. Other studies on food waste management focus on options lower down the food waste hierarchy including: re-use, recycling, recovery and disposal, even though these are the less preferred options. This study, therefore, adopted and focused on food waste prevention in food service operations based on the economic, social and environmental benefits over other food waste management options.

2.4 THE TRIPLE BOTTOM LINE: A FRAMEWORK FOR SUSTAINABILITY

The following section describes the framework for sustainability i.e., the triple bottom line. Additionally, the dimensions of sustainability; economic, social and environmental, as per the triple bottom line framework, are discussed.

2.4.1 The concept of triple bottom line

The concept of triple bottom line (TBL) was first pioneered by John Elkington in 1994 in an attempt to broaden the business focus to include environmental and social impacts of operations, in addition to the economic benefits (Boley & Uysal, 2014). The triple bottom line approach can be described as a sustainability concept that integrates economic, social and environmental responsibilities of an organisation (Jackson *et al*., 2011). The term TBL is in essence used to emphasise processes and activities that organisations must execute to maximise the positive environmental, social and economic impacts and to minimise the negatives (Boley & Uysal, 2014).

2.4.2 The dimensions of triple bottom line

As highlighted above, the triple bottom line comprises three dimensions: economic, social and environmental (Figure 2.24). In line with the scope of the study, the economic, social and environmental implications of food waste in the context of food service operations, are highlighted in the following section.

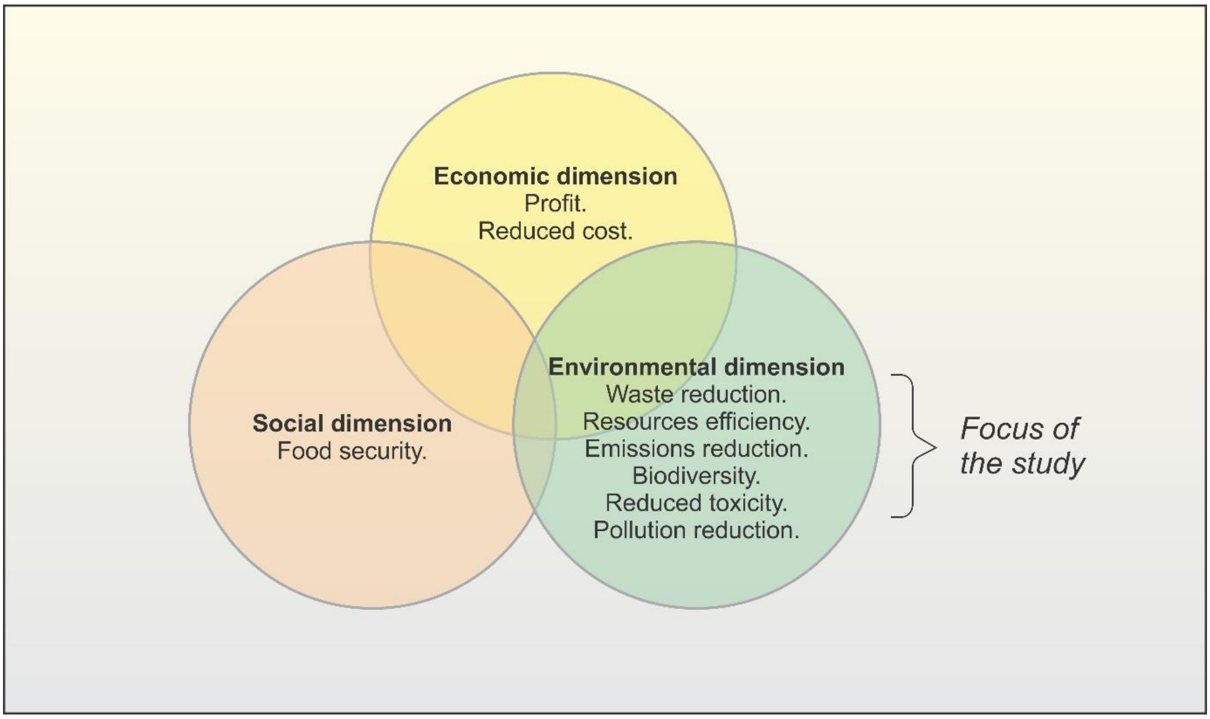


FIGURE 2.24: THE TRIPLE BOTTOM LINE APPROACH

2.4.2.1 The economic dimension

The economic dimension focuses on the financial performance of an organisation (Stoddard, Pollard & Evans, 2012). In terms of this study, preventing food waste has numerous economic benefits. Several authors agree that preventing food waste in food service operations, reduces economic losses associated with discarding food (Lundqvist *et al*., 2008; Nahman *et al*., 2012; Parizeau, Von Massow & Martin, 2015; Pham, Kaushik, Parshetti, Mahmood & Balasubramanian; 2015; Quested *et al*., 2013; Whitehair *et al*., 2013). Reducing food waste benefits food service operators in gaining economic benefits in two ways; first, the efficient use of limited resources (water, energy, labour) results in saving costs embedded within resources, and second, by reducing costs linked to food production and disposal of food waste (Nahman *et al*., 2012, Papargyropoulou *et al*., 2016).

2.4.2.2 The social dimension

The social dimension of sustainability is concerned with the welfare of the organisation's internal community (employees) and the external community (Kucukvar & Tatari, 2013). With the aim of the study in mind, the issue of food waste is to some extent driven by its social impact in the community (Abeliotis *et al*., 2014; Gustavsson *et al*., 2011; Nahman *et al*., 2012; Ofei *et al*., 2014). A large amount of food fit for human consumption and which could potentially feed some of the world's hungry population, is wasted (Gustavsson *et al*., 2011). Reducing food waste is a potential solution to food insecurity and feeding the growing world population (Oelofse & Nahman, 2013).

2.4.2.3 The environmental dimension

The environmental dimension of sustainability is often related to waste, pollution and emissions, as well as resource efficiency (Gimenez, Sierra & Rodon, 2012). In this study, it is argued that food waste reduction is an important sustainability move that reduces the burden on the environment. Additionally, the adoption of sustainable practices, which lowers the environmental risk of food service operations, and raises ecological efficiency, is emphasised. Important elements of environmental sustainability are: local purchasing, reduced food miles, energy conservation, efficient equipment and appliances, water efficiency, utilisation of seasonal foods, organic foods, use of animal welfare approved products, more plant-based dishes and less animal-based dishes, as well as the reduction of processed foods (Akkerman, Farahani & Grunow, 2010; Baldwin *et al*., 2011; Green Restaurant Association (GRA), 2015; Pinard *et al*., 2014; Shokri, Oglethorpe & Nabhani, 2014; Textile Rental Services Association (TRSA), 2014; Wang, Chen, Lee & Tsai, 2013). The environmental dimension of sustainability is further elaborated in the following Chapter Three (3).

In this study, the focus was on the environmental aspect of the triple bottom line approach; looking into sustainable practices that cause less impact on the environment and reduce food waste.

2.5 SUMMARY

Following the discussion of the application of the systems theory, the food waste hierarchy and environmental sustainability, the theories and approaches are integrated to form the newly proposed sustainable systems framework to address food waste in food service operations (Figure 2.25 – next page). This framework was applied throughout the entire study.

The next chapter provides a review of the literature on the main constructs of the study. Specifically, the chapter reviews food waste in the context of food service operations, total quality management practices and sustainable practices in food service operations.

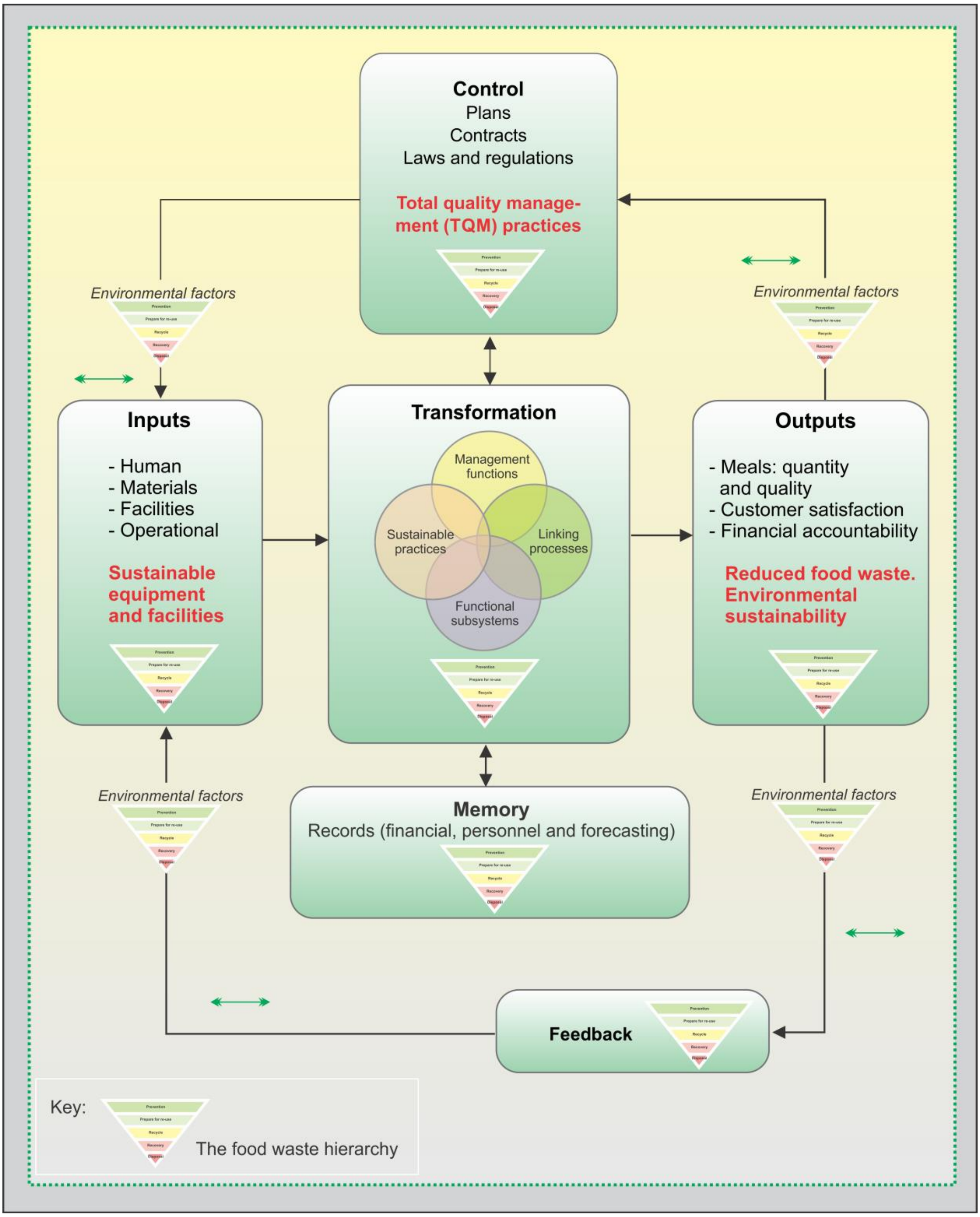


FIGURE 2.25: THE THEORETICAL FRAMEWORK OF THE STUDY

Chapter 3: SUPPORTING LITERATURE REVIEW

Chapter 3

SUPPORTING LITERATURE REVIEW

This chapter provides a review of the literature on the constructs of food waste in the context of food services, total quality management practices and sustainable practices in food service operations.

3.1 INTRODUCTION

This chapter presents a review of the literature pertaining to specific areas considered important to support the study objectives and the theories discussed in Chapter Two (2). The supporting literature is presented in four sections. First, the food system and the food service sector are discussed to provide the context in which the study was conducted. Secondly, food waste in the context of food service units is discussed including a conceptualised definition of food waste, the magnitude of food waste to show the extent of the problem, causes of food waste to inform food waste prevention strategies, and the importance of current approaches to prevent food waste. Thirdly, the chapter reviews the concept of total quality management and examines how these practices may contribute to the generation of food waste or its prevention. Fourthly, sustainable practices of food service operations are reviewed and their potential influence on food waste generation or prevention is analysed by consulting the existing literature.

3.2 THE FOOD SUPPLY CHAIN (FSC)

The following subsections give an overview of the food supply chain and the different stages to lay a foundation for the study.

3.2.1 An overview of the food supply chain (FSC)

The concept of the food supply chain dates back several dedades, but has regained prominence in recent years amongst scholars and policy makers (Béné, Oosterveer, Lamotte, Brouwer, De Haan, Prager & Khoury, 2019). This re-emergence of interest in food supply chains is driven by multiple concerns including environmental matters, food insecurity, sustainability, dietary and health issues, food safety and food wastage, amongst other things (Béné *et al*., 2019). This study explored the generation of food waste and its prevention in the food supply chain, specifically in the university food service units. To understand the context, this section provides background information on the food supply chain and the food service segment on which the study focuses. The food supply chain (FSC) (also termed as the food system by some researchers) is a complex system, which consists of different activities and actors who play different roles from primary food production until final consumption (Chiffoleau *et al*., 2019). The High Level Panel of Experts on Food Security and Nutrition (HLPE), (2017:11) defined the food supply chain as '…all activities and actors that move food from production to consumption, which includes production, storage, distribution, processing, packaging, retailing and marketing'. Different authors use different categories to illustrate and describe the food supply chain. Consistent with numerous food waste studies (Govindan, 2018; Gustavsson *et al*., 2011; HLPE, 2017; Parfitt *et al*., 2010), this study conceptualised the food supply chain as the food pathway from agricultural farms to consumers. The food supply chain entails various activities, conducted throughout these stages: primary production, postharvest handling and storage, processing and packaging, distribution, retail, markets and food service, and final consumption by the consumers. Figure 3.1 depicts a diagram of the food supply chain and highlights the sector on which the study focused.

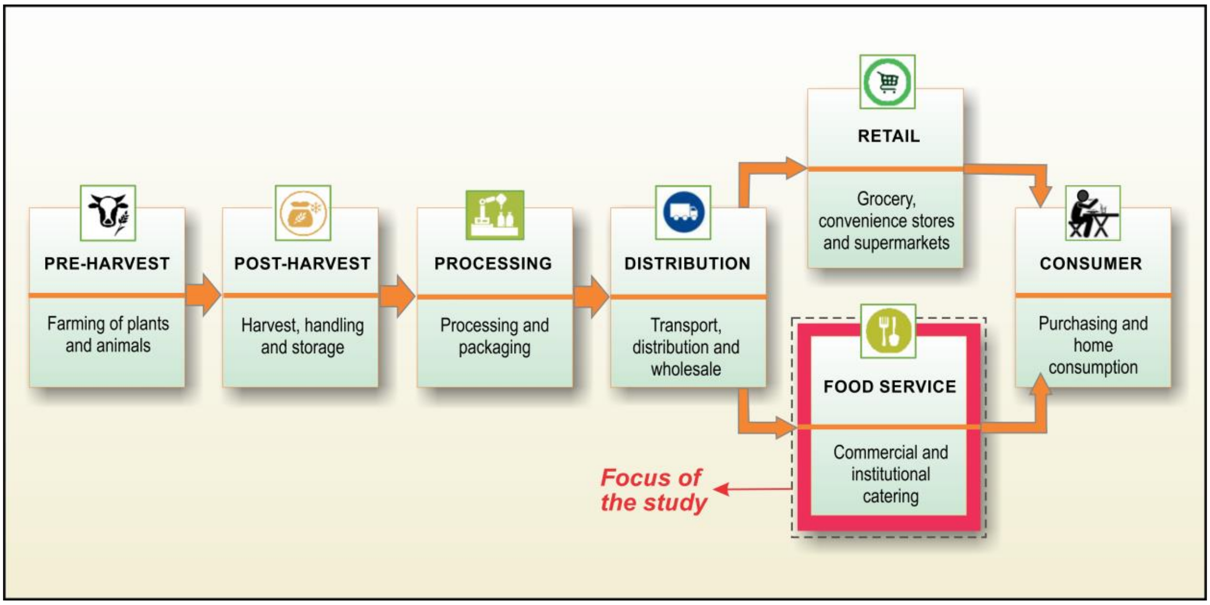


FIGURE 3.1: THE FOOD SUPPLY CHAIN MODEL (Adapted from Commission for Environmental Cooperation, 2017)

The following subsections include a discussion on the different stages of the food supply chain.

3.2.1.1 Preharvest or primary production

This stage entails the food production activities, which occur within the agricultural sector at farm level (Gustavsson *et al*., 2011). It is the initial stage of the production of raw food materials prior to harvest. It involves the farming of plants and animals (Commission for Environmental Cooperation, 2017). Specifically, primary production involves farming operations such as soil agitation, seeding, cropping, pest control, nutrient and water management (Accorsi, Cholette, Manzini & Tufano, 2018; Yu & Nagurney, 2013).

3.2.1.2 Postharvest handling and storage

According to the Commission for Environmental Cooperation (2017:6), '…postharvest handling and storage encompasses the post-harvest activities at the farm level and those occurring outside the agricultural sector – this involves; harvesting, handling and storage of plants or their parts, or of animals (livestock, poultry, seafood) or their parts'.

3.2.1.3 Processing and packaging

Food processing (or manufacturing) and packaging involves the transformation of raw food materials into products suitable for preparation, consumption, storage, or packaging to lengthen their shelf life (Commission for Environmental Cooperation, 2017). Different processing technologies result in varying levels of product readiness for preparation and consumption. The major processing activities involve cleaning, sorting or grading, cutting, peeling, blanching or cooling, labelling and packaging (Accorsi *et al*., 2018; Yu & Nagurney, 2013). At this stage, food products are packaged primarily to limit oxidation and water activity, which would trigger food spoilage and bacterial growth, hence leading to food loss (Manzini & Accorsi, 2013).

3.2.1.4 Distribution

The food supply chain model (Figure 3.1) indicates that processing is connected to distribution, which denotes that food products are collected from processors and distributed to centres and then to the demand markets (Yu & Nagurney, 2013). A modern supply chain involves collection and shipment of food products around the world, resulting in complex handling activities and logistical processes, such as the design and optimisation of warehousing systems, planning of distribution networks, the design of distribution centres, flow of materials, delivery scheduling and others (Li, Wang, Chan & Manzini, 2014).

3.2.1.5 Retail and food service

At the retail and food service stage, food is sold to consumers directly. Retail is defined as the sale of food by businesses, such as; grocery stores, convenience stores, supermarkets and others, to consumers for use at household level (Commission for Environmental Cooperation, 2017). Food service encompasses preparation and service of meals and beverages for consumption by consumers outside the home, in dining establishments within a commercial and non-commercial (institutional) setting (Commission for Environmental Cooperation, 2017).

3.2.1.6 The consumer

Finally, the food reaches the consumer for consumption at household level (Gustavsson *et al*., 2011).

The following section gives a detailed discussion of the food service industry, which is the main focus of the study. In subsequent sections, the magnitude of food loss and waste across the food supply chain will be highlighted, with the emphasis on the food service sector.

3.2.2 The food service sector

Over the years, the consumption of food outside the home has gained popularity. The number and range of food service operations has increased considerably in recent years (Edwards, 2013). According to a report commissioned by Clairfield International (2017:5) '…the total food service sales value worldwide is estimated at US$3.4 trillion, growing at 4.6% per annum in 2016 and 2017, and the industry is estimated to employ 10.8 million people'. Despite the growth of the food service industry, there is no shared or standard definition for the term food service. In this study, the term food service is conceptualised as the serviced provision of food and beverages (meals) to consumers outside the home, for consumption both in and out of the home (Edwards, 2013; Martin-Rios *et al*., 2018; Silvennoinen, Heikkilä, Katajajuuri & Reinikainen, 2015; WRAP, 2013). The concept 'serviced' in provision of meals is important in that it distinguishes meals that are provided in food service units from meals provided in other sectors, such as retail or supermarkets (Edwards & Causa, 2009). Food service operations are classified on the basis of whether food is provided as a primary or secondary function.

There are two important categories: the commercial (profit) sector and the non-commercial (cost or on-site) sector (Betz *et al*., 2014; Edwards, 2013) (Figure 3.2).

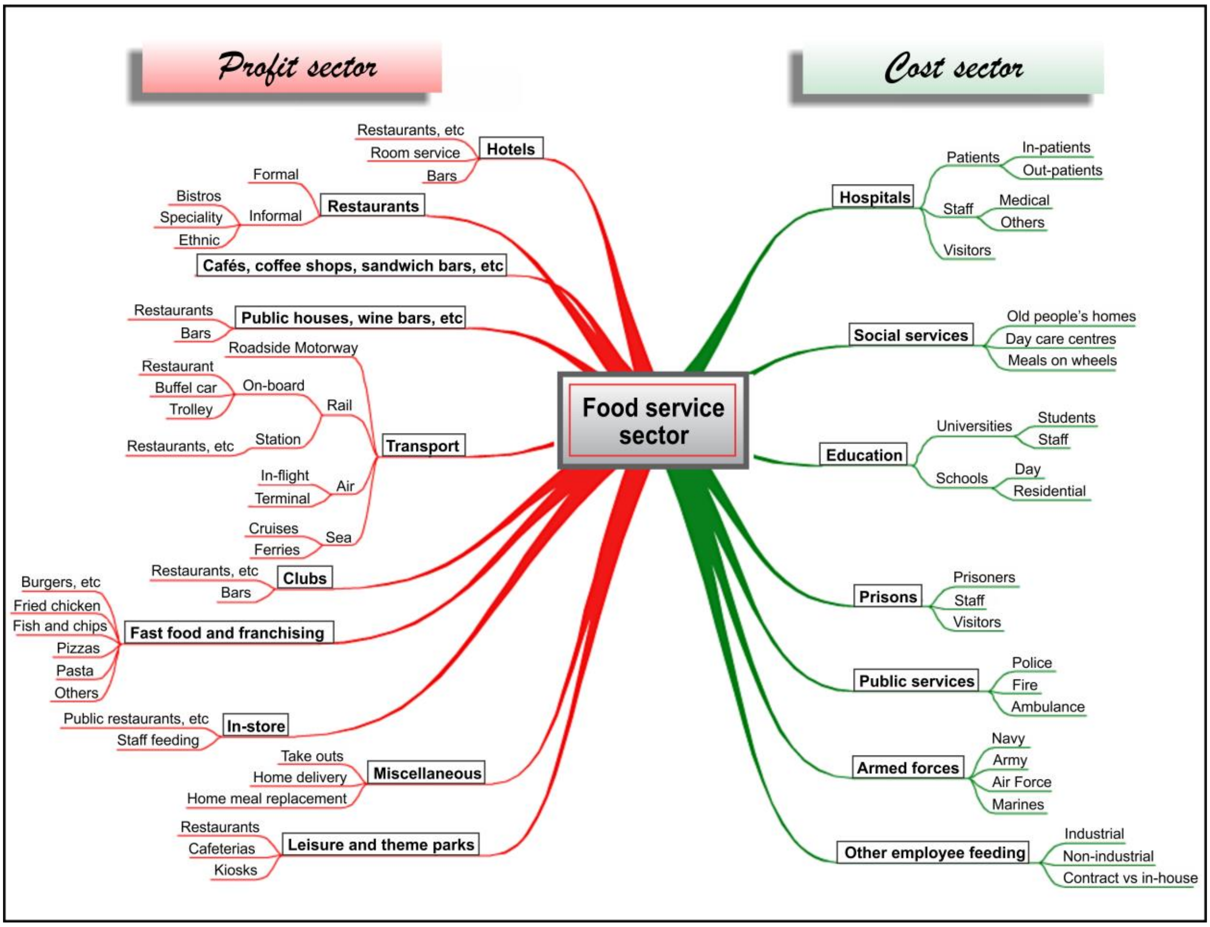


FIGURE 3.2: CATEGORISATION OF THE FOOD SERVICE INDUSTRY (Edwards & Causa, 2009:3)

3.2.2.1 The commercial (profit) sector

The commercial or profit sector includes food service establishments in which the sale of food is the primary function of the operation and profit is the desired output (Gregoire, 2013:11). It covers a wide spectrum of types of food outlets as indicated in Figure 3.2. As illustrated in Figure 3.3, the commercial food service sector is the largest worldwide with approximately 65% of all food outlets (Clairfield International, 2017).

3.2.2.2 The non-commercial (non-profit, cost or public) sector

The second category of food services is the non-commercial; cost or public sector (Edwards, 2013), which can be defined as food service operations in which food provision is secondary to the goal of the organisation (Gregoire, 2013:14). The size of the non-commercial or cost food service sector worldwide is approximately 35% (Figure 3.3), making it smaller compared

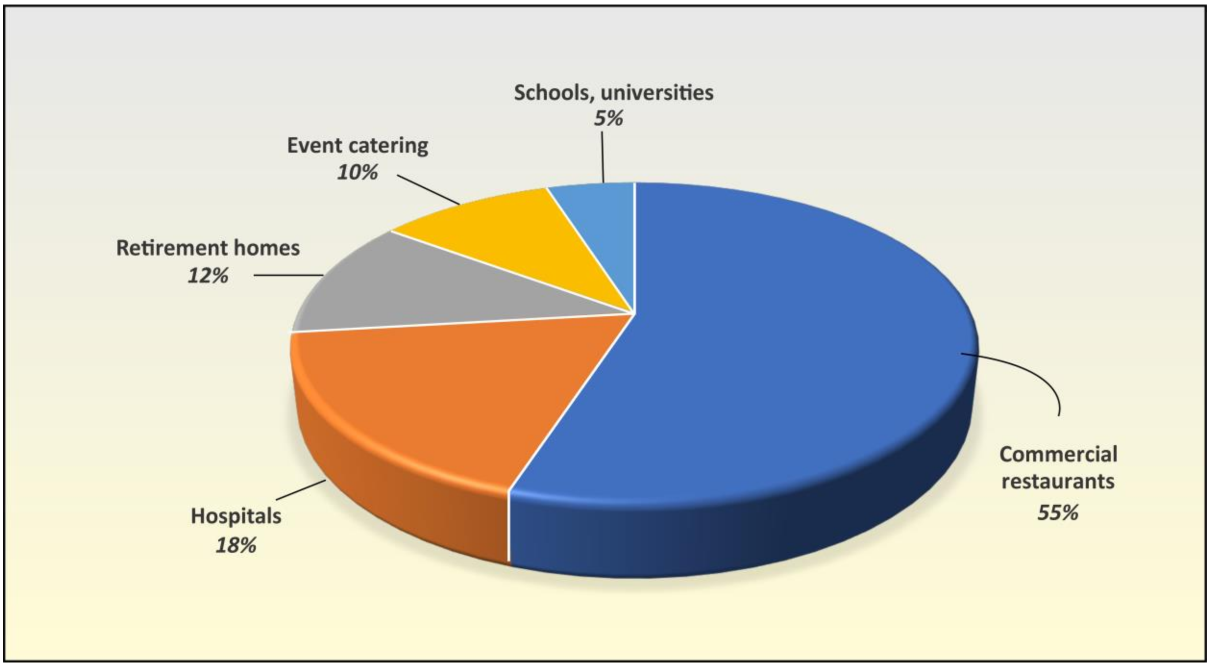


FIGURE 3.3: THE FOOD SERVICE INDUSTRY WORLDWIDE BY MARKET SHARE (Clairfield International, 2017:6)

to its commercial counterpart – 65% (Clairfield International, 2017). According to Edwards (2013), the importance of the non-commercial food service sector is often overlooked and under-researched. For this reason, the current study focuses on this neglected sector, particularly university food services.

The review of the literature clearly indicates that the generation of food waste in food services somewhat differs from the category or type of food service. Generally, non-commercial or institutional food service units appear to generate more food waste than commercial food service operations. For example, a study commissioned by the Swedish Environmental Protection Agency indicated that a total of 70 000 tonnes of food waste per annum is generated by Swedish public food services including; schools, pre-schools, elderly care homes, hospitals and prisons, whereas commercial food services generate 66 000 tonnes of food waste annually (Eriksson, Osowski, Björkman, Hansson, Malefors, Eriksson & Ghosh, 2018). Another survey established that 24% of food waste was generated in schools, 40% in a military mess, 25% in a staff cafeteria and 34% in a commercial restaurant (Engström & Carlsson-Kanyama, 2004). These findings demonstrate the significant amount of food waste generated in both commercial and non-commercial food services. In a study conducted by Silvennoinen *et al.* (2015), most food waste was generated in non-commercial food services; schools – 16.9%, day care centres – 28% and student canteens – 25.3%, while in commercial food services 19.5% and 18.8% was wasted in cafes and restaurants, respectively. For this reason, the study investigated food waste in the context of a non-commercial food service sector i.e., university residential food service units.

3.2.3 University residential food service

There is growth in university food services globally, as in South Africa (Garg & Kumar, 2017; Painter *et al*., 2016; Wu, Tian, Li, Yuan & Liu, 2019). University residential food service units can be defined as catering facilities for institutions of higher education or universities, which provide catering services to students staying within the university accommodation facilities (Davis *et al*., 2012:96). Generally, there is little literature but much interest in university residential food services in South Africa, driven by the growth in the student population. University enrolment in South Africa has increased steadily since 2000, with 975 837 registered students in 2016 (Statistics South Africa, 2017). It is projected that by 2030, university enrolment will rise to about 1.5 million students (Painter *et al*., 2016).

The literature indicates that traditionally university residential food service operations had a straight-line cafeteria arrangement, where customers enter at one end of the line, pick up a tray and pass along counters selecting their food (Davis *et al*., 2012:97). In the past, students living in university residential halls had to pay for food services in advance – a residential meal plan system, which restricted them to eat at the university residential food service units. In recent years, some universities have abandoned this method and students are provided with kitchen facilities to prepare and cook meals for themselves (Davis *et al*., 2012:97). Other universities have introduced a flexible pay-as-you-eat system, which allows them to purchase meals outside the university residential food services (Davis *et al*., 2012:97). It was noted that there is a wide range of food service methods in university residential food service operations, including self-service (eat-as-much-as-you-care), free-flow cafeteria and vending. In recent years, university food service operations have moved from being in-house providers where the university operated the food service, to outsourcing to food service companies. These developments have important implications on food waste generation and its prevention in university food service operations.

3.2.4 Types of food service systems

The food service systems have undergone several changes over the past few decades, owing to the changing demands of consumers, technological advances in both food and equipment, labour productivity and economic pressures (Assaf, Matawie & Blackman, 2008). Depending on the employees' skills, kitchen space and layout, equipment available, and forms and stages of preparation of food, four main types of food service systems may be applied namely; conventional food service, ready-prepared, commissary and assembly/serve food service systems (Ahmed *et al*., 2015; Rodgers, 2005; Spears & Vaden, 1985:75). These systems are discussed below.

3.2.4.1 Conventional

Historically, the conventional food service system was the most popular in many establishments, especially hospitals, schools and correctional facilities (Assaf *et al*., 2008). This system requires substantial labour input; as a result, food service operators are gradually shifting to others requiring less labour (Unklesbay, Maxcy, Knickrehm, Stevenson, Cremer & Matthews, 1977). According to Ahmed *et al*. (2015), in the conventional food service system, the preparation of ingredients, production, distribution and service are carried out and completed on-site. The level of intensity or range of transformation processes conducted in a conventional food service system differs from one food service operation to another. Figure 3.4 illustrates the food product flow for a conventional food service system. In this illustration, ingredients requiring varying degrees of processing are procured, prepared and produced for

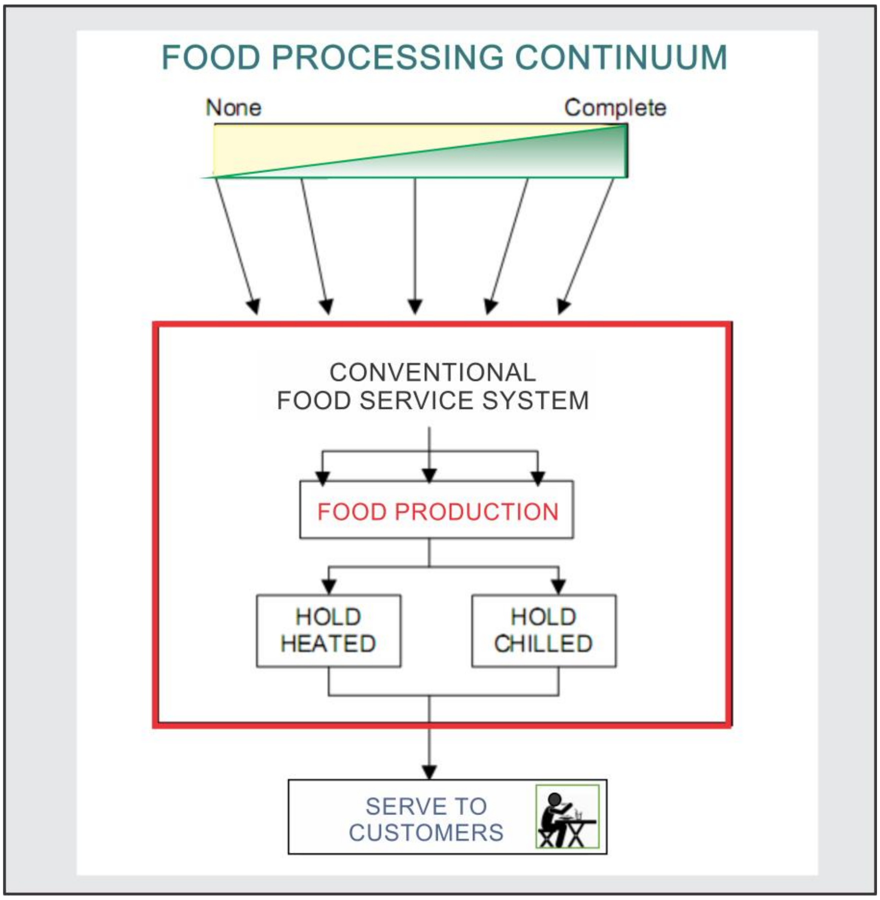


FIGURE 3.4: FOOD FLOW IN A CONVENTIONAL FOOD SERVICE SYSTEM (Spears & Vaden, 1985:77)

service (Spears & Vaden, 1985:76). In the conventional food service system, food can be held heated or chilled until the time of service or may be served immediately after production to customers (Spears & Vaden, 1985:76).

The conventional food service system is linked to food waste generation. In a study conducted by Kandiah, Stinnett & Lutton (2006), where they investigated visual plate waste in hospitalised patients, found that in a conventional food service system the majority consumed 39% of their main meal. This implies that approximately 60% of food was wasted by consumers. Another study by Beretta and Hellweg (2019) indicated that in a conventional food service system, food may be overproduced and is then discarded.

3.2.4.2 Ready-prepared

In recent years, many of the commercial food service operations, especially those providing food in mass, have adopted the ready-prepared food service system in response to increased labour costs, critical shortages of skilled food production personnel and convenience on the part of the consumer (Assaf *et al*., 2008). 'In ready-prepared food services, menu items are produced and held chilled or frozen until heated for serving.' (Greigoire, 2013:69). In this way, food is produced for inventory and subsequent withdrawal but not for immediate service as is the case with the conventional food service system (Spears & Vaden, 1985:82). The food product flow in ready-prepared food service systems is indicated in Figure 3.5. **Cook-chill** and **cook-freeze** are the two variations used in ready-prepared food service systems (Ahmed *et al*., 2015; Mavrommatis, Moynihan, Gosney & Methven, 2011; Rodgers, 2005). In cook-chill food service operations, the food preparation and production are followed by chilling and holding food in chill cabinets for up to five days, before being reheated for service. In cook-freeze systems, the food preparation and production is followed by fast freezing and storage in a frozen state until being reheated at the point of service (Ahmed *et al*., 2015, Yusof *et al*., 2018).

A study commissioned by Edwards and Hartwell (2006) indicated that the cook chill system generates a substantial amount of food waste; 27% wastage from the trolley and 22% from the plates, a total of 49%. These figures are an indication that the ready-prepared food service system has an influence on food waste generation.

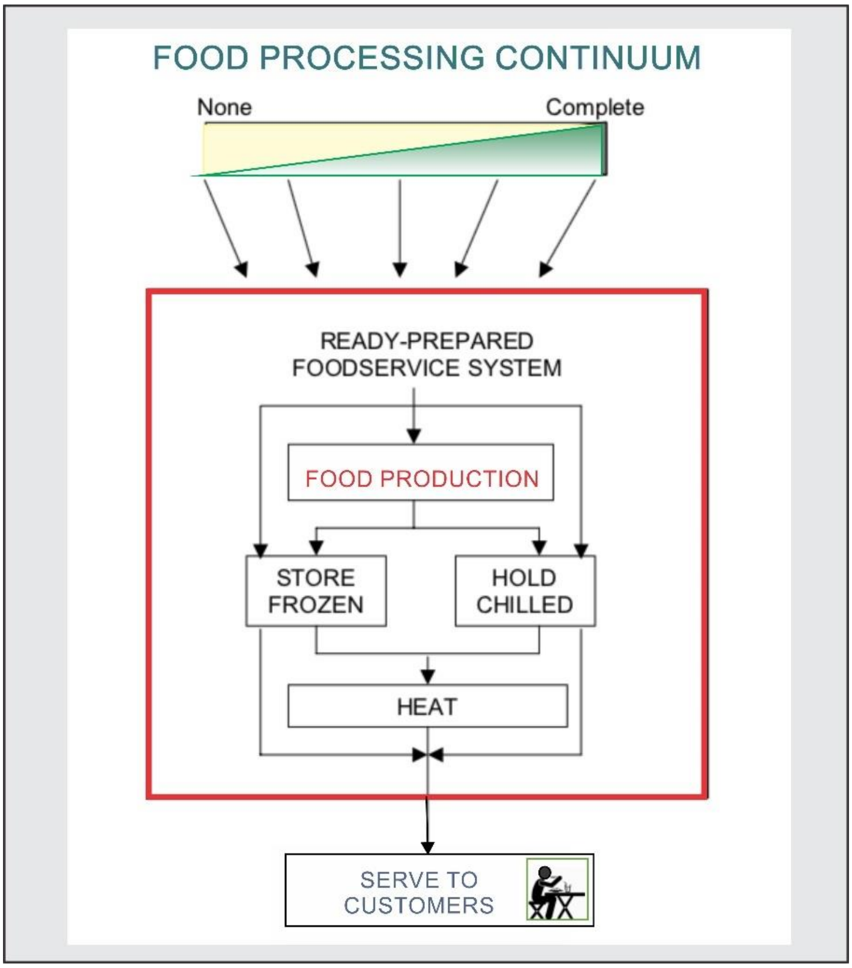


FIGURE 3.5: FOOD FLOW IN A READY PREPARED FOOD SERVICE SYSTEM (Spears & Vaden, 1985:82)

3.2.4.3 Commissary food service system

Technological developments and the design of large, sophisticated food service equipment has led to the evolution of the commissary food service system (Greigoire, 2013:73). This is described as a system where food is procured, produced and held in a central kitchen, with the distribution of prepared menu items to satellite service centres for final preparation and service (Ahmed *et al*., 2015; Cremer & Chipley, 1979; Unklesbay *et al*., 1977). As indicated in Figure 3.6, in the commissary food service system, food ingredients are purchased in a raw or partially processed state (Spears & Vaden, 1985:78). In this way, food waste may be generated from the preparation and production of food. The food is produced and held either frozen, chilled, or heated for distribution to satellite service centres (Greigoire, 2013:74; Unklesbay *et al*., 1977).

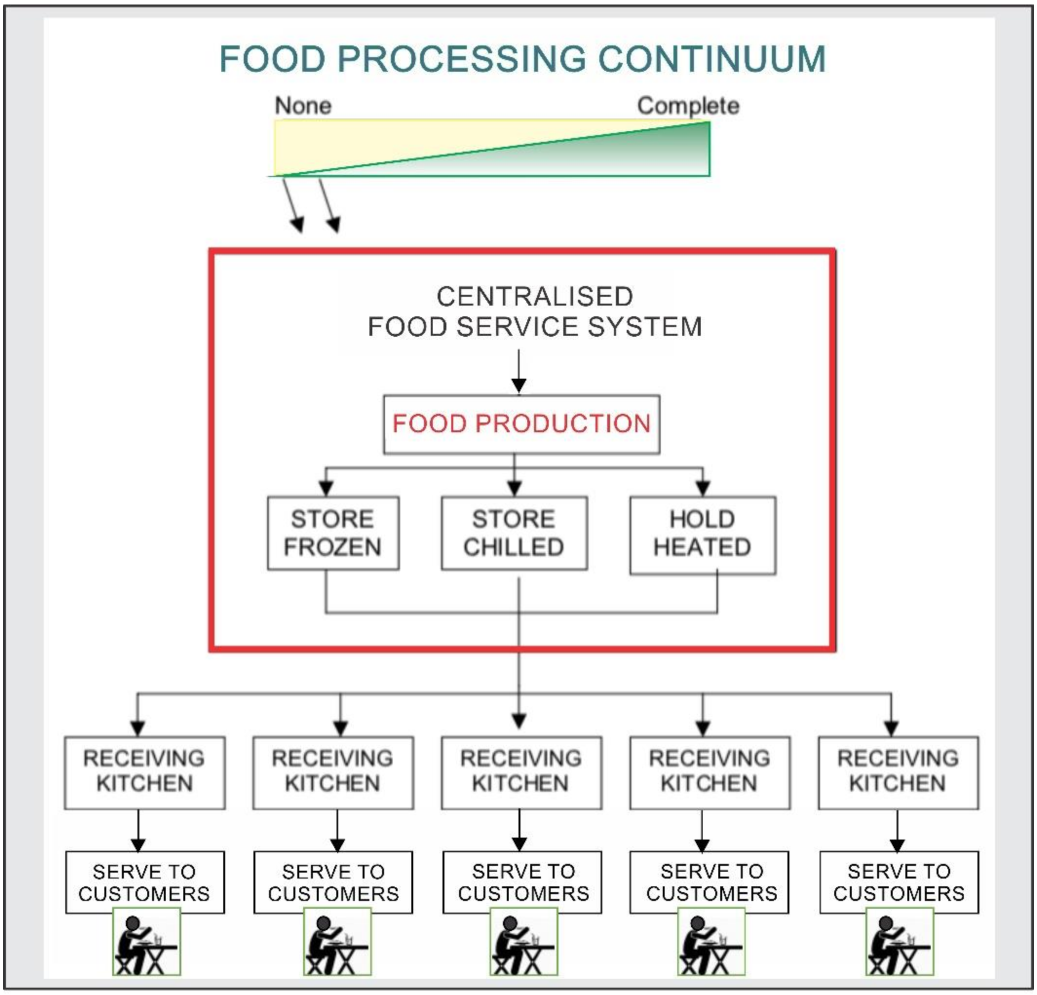


FIGURE 3.6: FOOD FLOW IN A COMMISSARY FOOD SERVICE SYSTEM (Unklesbay *et al*., 1977:11)

A study conducted by Eriksson, Osowski, Malefors, Björkman & Eriksson (2017) indicated that in a commissary food service system, satellite kitchens that received warm food from central production kitchens had a 42% higher food waste level than in kitchens that produce the food. This may be due to production kitchens having greater flexibility to control the right amounts of food to prepare, as well as better management of the surplus food (Eriksson *et al*., 2017).

3.2.4.4 Assembly / serve

The development of the assembly/serve system evolved as a result of the availability of high-quality foods that were ready to serve or required little processing prior to service. The chronic shortage of skilled food production workers, and the extensive marketing and distribution system of frozen food products, added to the implementation of this system (Unklesbay *et al*., 1977). Ahmed *et al*. (2015) described the assembly/serve food service system as one of convenience, which depends on purchasing fully-prepared foods that are stored and assembled, heated and served when required by consumers.

As illustrated in Figure 3.7, in assembly/serve systems, food procured by the food service operation is already processed to a maximum degree and requires no or little processing on-site (Gregoire, 2013:76; Hwang & Sneed, 2009). This implies that there is very limited production to be done at the point of service. The only functions required by the food service operations in this system are; storage, assembly, portioning, heating, and service (Unklesbay *et al*., 1977).

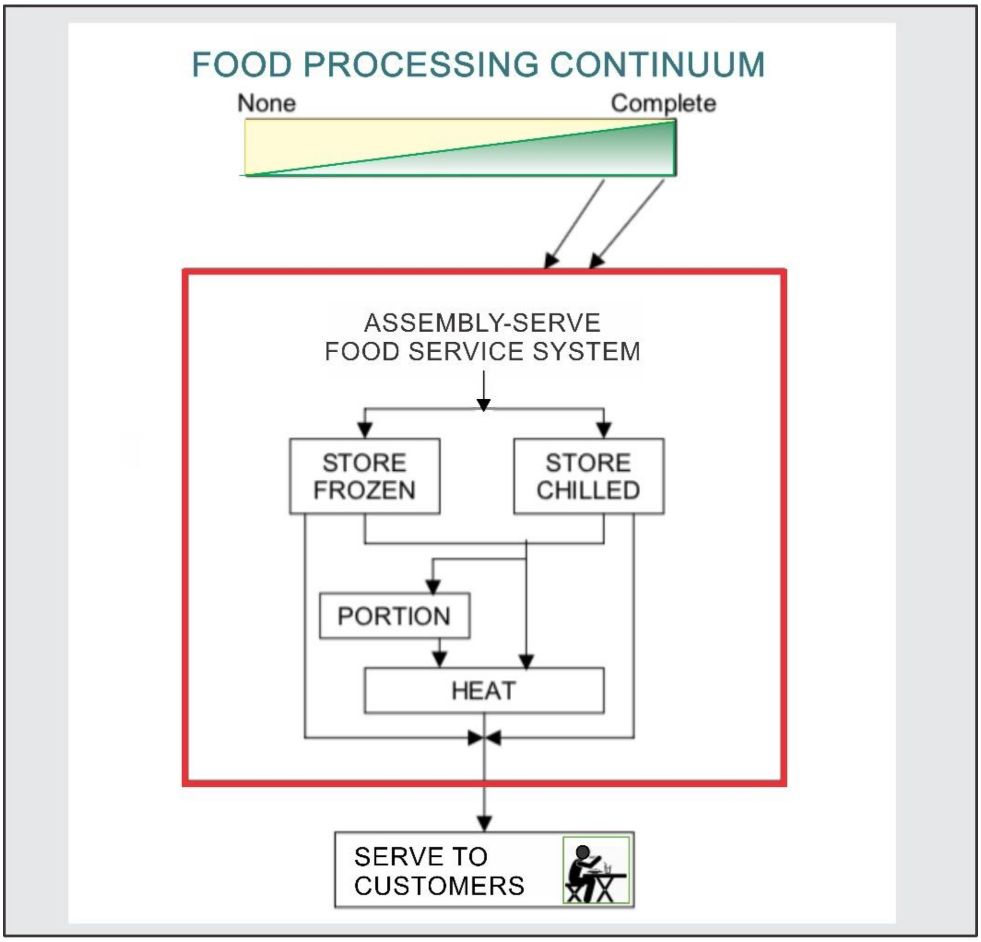


FIGURE 3.7: FOOD FLOW IN AN ASSEMBLY/SERVE FOOD SERVICE SYSTEM (Unklesbay *et al*., 1977:17)

A study conducted by Edwards and Nash (1999) in a hospital setting, indicated that the assembly/serve food service system where food was purchased pre-prepared, generated a substantially higher plate waste than the conventional food service system. Specifically, in the surgical wards, the assembly/serve system generated 51.58% plate waste versus 17.04%

when using the conventional system. In the wards for the elderly, it was 46.10% and 24.56% wastage, respectively (Edwards & Nash, 1999). However, the assembly/serve food service system is considered less wasteful at the production stage because there is minimal or no food processing in the food service units (Ahmed *et al.*, 2015).

The next section gives a detailed discussion on food waste in the context of food service units.

3.3 FOOD WASTE IN THE CONTEXT OF FOOD SERVICE UNITS

The following section includes a discussion about the term food waste and the magnitude of this from a global to a university food service sector perspective. The section further covers the causes of food waste, the importance of its prevention and different strategies implemented in the food service system.

3.3.1 What is food waste?

There are various forms of waste that can be generated by food service units, however, one that is gaining increasing attention is food waste (Christ & Burritt, 2017). The concept of food waste is seemingly straightforward, yet it is underpinned by considerable complexity with little universal consensus regarding its definition (Thyberg & Tonjes, 2016). A variety of terminologies and phrases have been used when discussing the subject of food loss and waste. Sometimes different terminologies are used for the same meaning, while at times the same terms are used for different meanings (Food and Agricultural Organisation, 2014). Thi *et al*. (2015) further pointed out that the definition and use of food loss and waste terms, is often content-specific and dependent on the author's opinion. Multiple terms including 'food loss', 'food waste' and 'food loss and waste' have been used interchangeably (Thi *et al*., 2015). The High Level Panel of Experts on Food Security and Nutrition (2014) have coined another food wastage term – 'food quality loss or waste'. Table 3.1 shows different food waste related terms and conceptualisations found in the literature.

With all the definitions tabulated, the element that appears to be missing that may be important for food service operations, is food that is wasted by other means though not discarded. This waste has economic implications but may be overlooked in studies that consider food waste as food that is discarded. The current study considers food waste to be that which is directed to other uses (whether food or non-food uses) other than the primary role of food sales.

TABLE 3.1: A COMPARISON OF DEFINITIONS OF FOOD WASTAGE TERMINOLOGIES

Reference	Concept	Definition
Beretta & Hellweg (2019)	Food waste	Food which is originally produced for human consumption but ends up directed to either non-food uses or waste disposal.
Betz *et al*. (2015)	Food waste or loss	All the food losses along the entire value-added chain; from farmer to the consumer.
De Lange & Nahman (2015)	Food waste	Food losses that occur throughout the food supply chain, including during production, storage, transportation, and processing, as well as food that is discarded by retailers, and in the kitchens of restaurants and households.
Filimonau & De Coteau (2019)	Food waste	Discarding or alternative non-food use of food that was originally meant for human consumption, as a result of damage or spoilage caused by operational inefficiencies or irresponsible behaviour of food providers and consumers.
Food and Agricultural Organisation (2014)	Food waste	Food waste is part of food loss and refers to discarding or alternative (non-food) use of food that is safe and nutritious for human consumption along the entire food supply chain, from primary production to the end at the household consumer level.
Goonan *et al*. (2014)	Food waste	Kitchen waste that could be classified as either avoidable (food and drink thrown out, that was, at some point before disposal, edible in the vast majority of situations), or as possibly avoidable (food and drink thrown out that some people eat, and others do not, or that can be eaten when food is prepared in one way but not another).
Halloran *et al*. (2014)	Food loss or waste	Food lost or wasted along the food supply chain providing edible products for human consumption.
Heikkila *et al*. (2016)	Food waste	Focus on avoidable food waste, which is defined as wasted food and raw material that could have been consumed had it been stored or prepared differently.
High Level Panel of Experts on Food Security and Nutrition (HLPE) (2014)	Food quality loss or waste	Decrease in the quality attributes of food linked to the degradation of food at different stages of the food chain.
Nahman *et al*. (2012)	Food waste	Losses that occur before food reaches the end users as well as food that is discarded by consumers.
Oelofse & Nahman (2013)	Food waste Food loss	Raw or cooked food materials that are discarded before, during and after meal preparation in the household. Food lost in the process of food manufacturing, distribution, retail and food service activities.
Papargyropoulou *et al*. (2016)	Food waste	Food, which was originally produced for human consumption but was not consumed by humans, instead it was directed into non-food uses.
Thi *et al*. (2015)	Food loss	Food products lost during the production phase.
Thyberg and Tonjes (2016)	Food loss Food waste	The decrease in the edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food, which was originally produced for human consumption but then was discarded or not consumed by humans.

Different studies (Betz *et al*., 2015; Charlebois *et al*., 2015; Goonan *et al*., 2014; Katajajuuri, Silvennoinen, Hartikainen, Heikkilä & Reinikainen, 2014; Sonnino & McWilliam, 2011), which focused on food waste in the food service sector, have used the term food waste and food loss interchangeably. However, according to Filimonau and De Coteau (2019), the key difference between food loss and food waste is that food loss is characterissed by largely unintentional occurrence while food waste arises due to both unintentional and intentional human actions and operational deficiencies. In this study, the term food waste was adopted and defined as the edible parts of food intended for human consumption that are lost or discarded at some point along the food service system. Additionally, the definition of food waste from a monetary perspective is (1) the amount of food directed to other uses other than the primary purpose for which it was procured by the food service unit, which is the sale of food items to consumers, (2) the loss of the added economic value linked to the degradation of the quality of food, such as freshness, shape, colour, consistency, taste to the point that they are close to being lost (High Level Panel of Experts on Food Security and Nutrition, 2014). These definitions are adopted for the reason that they provide an opportunity for the reduction or elimination of food waste as well as profit generation or cost recovery within the food service system.

It is worth noting that the research on food waste in the food service sector to date has been primarily focused on plate waste (Falasconi, Vittuari, Politano & Segrè, 2015; Freedman & Brochado, 2010; Saccares, Scognamiglio, Moroni, Marani, Calcaterra, Amendola & Morena, 2014; Schwartz, Henderson, Read, Danna & Ickovics, 2015; Smith & Cunningham-Sabo, 2014; Thiagarajah & Getty, 2013; Thorsen, Lassen, Andersen, Christensen, Biltoft-Jensen, Andersen & Tetens, 2015). What is notably missing is the understanding of other categories of food waste that occur at different stages of the food service system. For this reason, the study focused on food waste at different subsystems of the university food service operation.

3.3.2 Current status of the magnitude of food waste

The next section provides a discussion on the magnitude of food waste at global and South African level, specific stages of the South African food supply chain, different segments of food service, and different university food service units.

3.3.2.1 The magnitude of food waste at global level

According to the Food and Agricultural Organisation (2015), it is estimated that global food production must increase by 60% by 2050 to meet the demands of the increasing population, yet 40% of the food produced gets wasted. In terms of unit tonnes, Gustavsson *et al*. (2011) indicated that 1.3 billion tonnes of food per year was wasted globally. This was equivalent to one third of the total food produced for human consumption (Gustavsson *et al*., 2011). Other studies (Lundqvist *et al*., 2008) suggested that as much as half of the food intended for human consumption was lost or wasted before and after it reached the consumer. The literature shows that in developing countries the larger proportion of food waste was generated at the beginning of the food value chain, whereas in developed countries major losses occur at the end (Betz *et al*., 2015). In general, developed countries are facing relatively greater challenges in the magnitude of food waste than developing countries (Figure 3.7). As illustrated in Figure 3.8, the per capita food wastage in developed countries, such as Europe, was estimated at 280 kg/year whereas in developing countries, such as sub-Saharan Africa, the per capita food wastage was approximately 170 kg/year (Gustavsson *et al*., 2011).

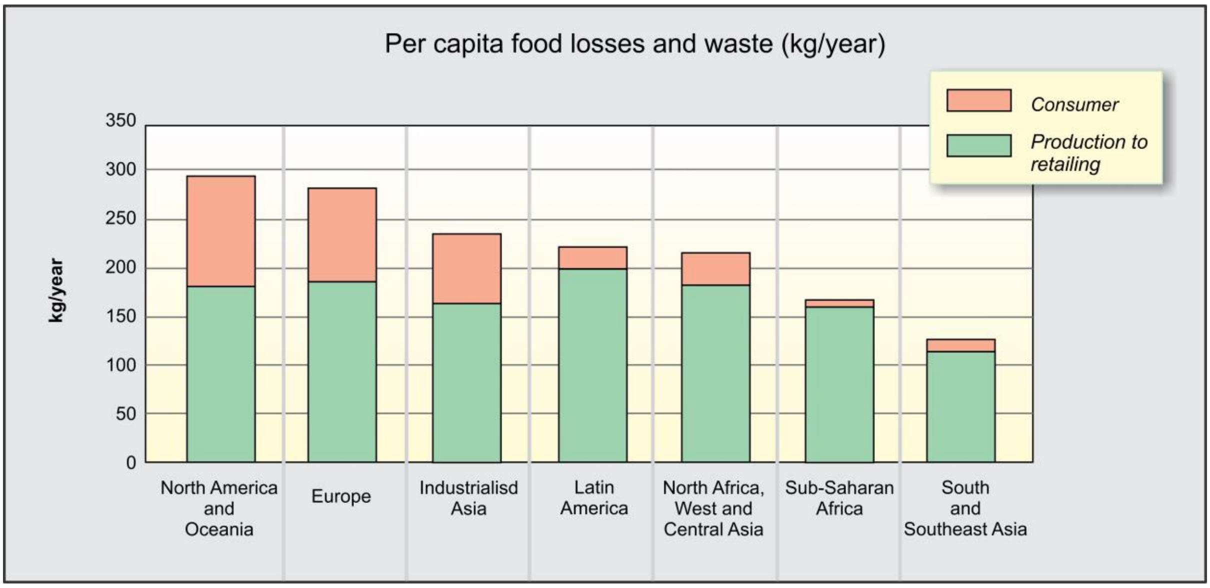


FIGURE 3.8: FOOD LOSSES AND WASTE ACROSS THE FOOD SUPPLY CHAIN IN DIFFERENT REGIONS (Gustavsson *et al*., 2011)

3.3.2.2 The magnitude of food waste in South Africa

In 2013, Oelofse and Nahman (2013) estimated that the overall amount of food waste generated in South Africa was approximately 9.04 million tonnes per annum. The recent statistics indicate that approximately 10 million tonnes of food waste is generated per year, which is a 10% increase from the estimated amount of food waste in 2013 (World Wide Fund for Nature-South Africa (WWF), 2017). This translates to a third of the food produced for consumption annually, which is never consumed and ends up in the landfills (WWF, 2017).

On a per capita basis, 210 kg per capita of food waste is generated per year (WWF, 2017), which indicates that this is higher than in developed countries (107 kg/year).

The Council for Scientific and Industrial Research (CSIR) has quantified the financial burden of edible food waste in South Africa at R61.5 billion, which is equivalent to 2.1% of the national gross domestic product (GDP) (Nahman *et al*., 2012). Taking into account the waste disposal costs and the value forgone by not diverting food waste into non-food uses, the total cost of food waste in South Africa was estimated at R75 billion in 2013 (De Lange & Nahman, 2015). Given the alarming magnitude of food waste, it is imperative to develop strategies to reduce and prevent food waste.

3.3.2.3 Food waste along the South African food supply chain (FSC)

The magnitude of the problem of 50% total food loss and waste in South Africa varies across the food supply chain. Figure 3.9 below indicates the proportion of food waste generated at each stage of the food supply chain. Agricultural production, pre-harvest and post-harvest food losses are a major concern, which suggests a significant amount of food wastage occurs earlier in the food supply chain (WWF, 2017). A pilot study tracking food loss and waste of spinach along the entire food supply chain, demonstrated that from a total of 100 g of spinach, 74 g was lost or wasted (WWF, 2017). Of the loss and waste incurred, 29 g was lost during agricultural production, 38 g during processing and packaging, 0 g in distribution and 7 g in store (WWF, 2017).

In South Africa, it is estimated that the processing and packaging stage accounts for approximately 25% of food lost in the food supply chain, where fruits and vegetables accounted for nearly 70% (Oelofse & Nahman, 2013). As indicated in Figure 3.9, the distribution and retail stage, accounts for 20% of the total food losses (WWF, 2017). When compared to developed countries, food waste at the distribution and retail stage is low but still worrying. A study conducted by Le Roux (2017) indicated that food waste in the perishable retail sector was estimated at an average of 7.381% per week of total products procured and delivered to retailers. This estimate is based on food waste generated by only one retailer thus is not representative of the whole retail sector in South Africa. The review of the literature indicated that there are few empirical researches conducted, which quantify food waste generated in food service operations. Only two studies focused on food waste in university food service operations (Marais *et al*., 2017; Painter *et al*., 2016) Findings of these studies indicated that a substantial amount of food waste was generated in university food service operations. These findings are discussed in the following sections.

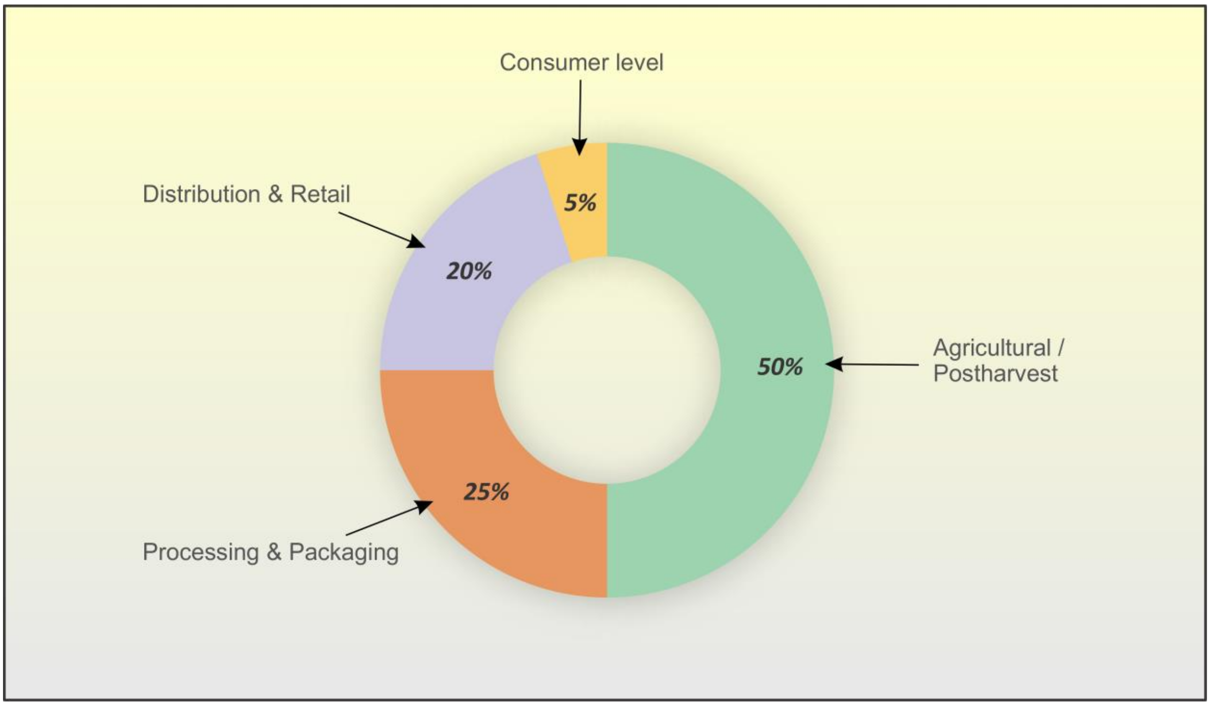


FIGURE 3.9: FOOD WASTE ALONG THE SOUTH AFRICAN FSC (Adapted from WWF, 2017)

Most empirical research in South Africa has focused on household food waste. It was indicated that household food waste is 5% of the food waste generated at consumer level along the food supply chain (WWF, 2017). A recent study by Oelofse *et al*. (2018) concluded that an average of 0.48 kg and 0.69 kg of food waste is disposed of per household per week in the municipalities of Ekurhuleni and Johannesburg, respectively. Based on these figures, the amount of food waste disposed to landfills by urban households of Ekurhuleni and Johannesburg is approximately 25 198 – 51 462 tonnes per annum (Oelofse *et al*., 2018). In another study conducted in Kimberley, South Africa, consumers generated approximately 5% food waste (Cronjé, Van der Merwe & Müller, 2018). The findings of this study may not be a true representation of the household food waste level as it was based on self-reported results. Oelofse and Marx-Pienaar (2016) conducted a study investigating the types of food wasted at household level. They found that the majority of respondents (58%) reported they wasted more than 20% of their weekly fresh produce. In a study conducted by Ramukhwatho *et al*. (2014), it was indicated that an average of a 24 kg bag of food waste was disposed of per week per household in the township of Mamelodi, South Africa. Their follow-up study indicated that households in the City of Tshwane Metropolitan Municipality wasted an average of 6 kg of food per week (Ramukhwatho *et al*., 2018).

3.3.2.4 Food waste in the food service sector – a global comparative analysis

The food service sector generates a considerable amount of food waste. Research indicated that in all of the 28 European Union countries the food service sectors generated a total of 11 million tonnes of food waste (Food Use for Social Innovation by Optimising Waste Prevention Strategies (FUSIONS), 2016). In the United States of America, 16 million tonnes of food waste was generated by full-service restaurants, institutional food services and limited service restaurants (Rethink Food Waste (ReFED), 2017). This translates to an equivalence of 25% of the total food supply chain food waste (ReFED, 2017). According to a study by Betz *et al*. (2014), in Switzerland the food service industry was the third largest source of food waste (18%) after households and the food industry. In Germany, Kranert, Kusch, Huang & Fischer (2012) evaluated the amount of food loss and waste along the food supply chain (FSC). They found that the food service industry was the second largest source, of approximately 1.9 million tonnes of food waste, which represented 17% of the total FSC food waste (Hennchen, 2019). In the UK, the food service sector accounted for 29.6% of food wasted in the entire food supply chain of which the largest contributors are restaurants, pubs, education and healthcare food services, in that order (The Waste and Resources Action Programme (WRAP), 2013). In Finland, the food service sector wasted about 75 – 85 million kgs of food per year, which represented 20% of all food handled and prepared (Silvennoinen *et al*., 2015). In this study, the largest contributors of food waste were day-care centres, workplaces, and student canteens (Silvennoinen *et al*., 2015).

The review of the literature revealed that there is limited empirical research quantifying the total food wasted in the food service sector in various countries of the sub-Saharan region. The next section narrows the focus to the magnitude of food waste in the university food service sector and further cites the amount of food waste generated in the specific context of South African university food services.

3.3.2.5 The magnitude of food waste in the university food service sector

The university food service sector may possibly make up a large source of food waste given the large number of students enrolled each year. Considering that a significant amount of food is produced each day for students who consume several meals per day at university food service units, addressing food waste in universities appears to be an important issue. Empirical research shows trends of appreciable food waste at institutions of higher education across the world. Several studies have documented food waste in the context of universities in the United States of America. A study undertaken at four different campus dining facilities at the University of Missouri in Columbia, found that of the 1000 kg food (6%) reaching the dining facilities, 56 kg was lost as kitchen food waste of which 41 kg was edible and 15 kg inedible (Costello, Birisci & McGarvey, 2015). The high proportion of the edible food waste generated was a major concern. An empirical study by Whitehair *et al*. (2013) estimated that a total amount of 1.5 tonnes of edible food waste was generated during a six week study at an American university dining facility, servicing 540 students living in residence halls. In another study, Babich and Smith (2010) estimated an average of 30 g of food was disposed of per meal in an American university setting. Thiagarajah and Getty (2013) compared the amount of plate waste generated using a tray versus a tray-less delivery system in a university dining hall. They found that 125 g of solid food per person was wasted when using the tray system versus 100 g per person with the tray-less system.

In Canada, a study undertaken by Rajan, Fredeen, Booth and Watson (2018) at the University of Northern British Columbia indicated that kitchen food waste made up the second largest component (32%) of total food waste generated by the University food service facility. Specifically, the study estimated that 29.4 kg of kitchen food waste was generated per day and in a period of a week, a total of 205 kg was produced. Rajan *et al*. (2018) further showed that starchy grain-based food waste was the single largest proportion (56%) of kitchen food waste. Another study in Canada by Gillard (2017) assessed and quantified food waste at the University of Saskatchewan. It was found that kitchen waste accounted for most of the food waste generated by the University cafeteria, with 59% being kitchen waste, 36% plate waste and 5% non-edible food waste.

In Portugal, a baseline visual waste observation at the University of Lisbon established that a third of plated meals ended up being discarded (Pinto, Dos Santos Pinto, Melo, Campos & Cordovil, 2018). The study estimated that plate waste amounting to 76.5 g per student per day was generated prior to the implementation of an educational campaign. Thereafter, it was reduced to 64.67 g (Pinto *et al*., 2018). Another study, conducted by Ferreira *et al*. (2013) in a different Portuguese university setting, estimated that each patron generated an average of 200 g of plate waste per meal. This is considerably higher compared to the study conducted by Pinto *et al*. (2018). Wong (2011), cited in Betz *et al*. (2015) estimated that 9.65% of the food reaching a certain German university canteen ends up being discarded. A study carried out in Turkey, at the Çurukova University's dining halls, indicated that about 10.7% of the served food gets wasted (Ozcicek-Dolekoglu & Var, 2019). In China, a study revealed that the average plate waste generated by Beijing university students was 73.7 g/ capita/ meal, with staples and vegetables contributing the most (Wu *et al*., 2019).

In the context of South Africa, two empirical studies have been conducted to establish the magnitude of food waste generated at Rhodes University and Stellenbosch University. A study conducted by Painter *et al*. (2016) reported that an estimation of 555 g of food waste per student was generated on a daily basis at Rhodes University, which translated to about 450 tonnes of food waste per year. This estimation indicated that food waste generated at Rhodes University is strikingly higher than an average amount of food waste generated by most universities. For instance, at the University of Florida (USA), the average amount of food waste generated per student is 159 g (Graunke & Wilkie, 2008), 170 g per student at Kansas State University (Whitehair *et al*., 2013), 73.7 g/capita/meal at universities in Beijing (Wu *et al*., 2019), and 200 g/capita/meal at a Portuguese university (Ferreira *et al*., 2013). On the other hand, the results of the study undertaken by Marais *et al*. (2017) indicated that 26.7% of food was discarded at Stellenbosch University residential food service units. This was a much higher percentage of food wasted, compared to 9.65% in a German university canteen (Betz *et al*., 2015). Given the magnitude of the problem, this study aimed at developing a tool that could be used to address food waste in the university food service system.

Understanding the causes of food waste is critical to conceptualising the magnitude of food waste generated. From the literature, the next section reviews the causes of food waste in the food service system.

3.3.3 Causes and drivers of food waste in the food service system

The identification of causes of food waste is necessary prior to the development of strategies to address food waste. However, there are limited studies, which have investigated these from the food service perspective. This section will review studies of food waste that have identified different causes of food waste in the context of the food service or catering sector. For the purpose of this study, the causes of food waste in the food service sector will be discussed from a systems perspective. This disentangled the complexity and diversity of causes of food waste, and in so doing, enabled the researcher to realise a holistic approach to addressing food waste.

3.3.3.1 Inputs

The review of the literature clearly indicated that inputs have an influence on food waste generation. With regards to human resources, the literature revealed that a lack of professional skills and knowledge of food service personnel had a significant effect on the amount of food waste generated (Charlebois *et al*., 2015; Goonan *et al*., 2014; Heikkilä *et al*., 2016; Kasavan, Mohamed & Halim, 2019; Pinto *et al*., 2018; Pirani & Arafat, 2014). For example, a study conducted by Kasavan *et al*. (2019) indicated that the lack of professional skills and incompetence in food preparation by food service workers is linked to the production of poor-quality meals, use of incorrect ingredients, and inaccurate interpretation of recipes, which results in food waste. Another study by Charlesbois *et al*. (2015) which focused on Delish restaurants in Canada showed that under-trained employees were unable to determine defects or poor quality of deliveries, hence restaurants had to absorb the waste instead of returning damaged food items to suppliers. Attitudes and habits of food service workers were also raised as contributing factors to food waste. For example, some workers are less concerned and less conscious of food waste, hence tend to generate more food waste (Goonan *et al*., 2014). Additionally, the number of food service personnel in a food service operation has an influence on food wastage; for example, in a study conducted by Prescott, Herritt, Bunning & Cunningham-Sabo (2019) participants felt that their staffing was stretched too thin for batch cooking thus had to produce food in bulk, which resulted in food waste.

Several studies revealed that the extent to which ingredients are processed has an influence on the generation of food waste; minimally processed ingredients that require preparation and cooking of food from scratch contribute more food waste at the preparation and production level than the more processed ingredients, which require little or no further preparation (Papargyropoulou *et al*., 2016; Pirani & Arafat, 2014). The quality of ingredients plays a role in food waste generation. For example, a study conducted by Heikkilä *et al*. (2016) indicated that brought-in bread resulted in more plate waste than freshly produced bread baked in the food service operation. Similarly, the sizes of batches of ingredients procured were sometimes a contributing factor to food waste. For example, ingredients purchased in larger than required sizes (where smaller units were not available) may be leftover and not managed properly, hence leading to storage waste (Heikkilä *et al*., 2016).

The literature further revealed that food service operation facilities (space and equipment) can contribute to food waste (Derqui *et al*., 2016 Kasavan *et al*., 2019; Thyberg & Tonjes, 2016; Williams & Walton, 2011). A study conducted by Kasavan *et al*. (2019) cited inadequate space, especially for the storage of food, as a leading factor in spoilage that resulted in the disposal of food. Another study that looked at food waste in school canteens indicated that dining environments that are noisy and too crowded are a driver of plate waste (Deirqui *et al*., 2016). With regards to operational resources; money, time and information are cited as contributing factors to food waste. According to Heikkilä *et al*. (2016), sufficient financial resources are needed to procure suitable equipment to reduce food waste. Time pressure and food service operational times are linked to food waste generation. A study conducted in hospital kitchens revealed that food service workers felt that time pressure increased food waste (Goonan *et al*., 2015). In agreement to this, findings of the study by Goh and Jie (2019) revealed that the food service workplace is fast-paced, so workers focussed more on getting the job done and serving the customers, rather than giving much thought to food waste generated at each stage of the food service system. In addition to that, the literature clearly indicates that the closing time for the operation of the food service unit as well as inadequate time available for dining, causes food waste (Burton, Serrano, Cox, Budowle & Dulys-Nusbaum, 2016; Prescott *et al*., 2019). For example, food service operations that adhere strictly to closing times, without much consideration for the amount of food left over after service, end up with food waste. The literature further shows that insufficient information was a contributing factor to food waste, for example, menus that are not informative by lacking vital information, such as the description of menu items and portion sizes, may lead to incorrect ordering. This may result in service and plate waste (Ofei *et al*., 2014; Sonnino & McWilliam, 2011).

3.3.3.2 Transformation

- *Functional subsystems*

  ⇒ *Procurement*

Careful attention is required to acquire the right food products for a food service operation at the right time and in a form that meets the specified standards of quality and quantity (Payne-Palacio and Theis, 2016). Purchasing poor quality food supplies, such as blemished and over ripe produce, was consistently cited as causes of food waste in the food service unit (Charlebois *et al*., 2015). Further to that, overstocking can also result in the generation of food waste (Martin-Rios *et al*., 2018; Thyberg & Tonjes, 2016). For example, if larger quantities of food are purchased that may not be prepared and cooked before expiry, spoilage occurred and the food ended up being discarded (Heikkila *et al*., 2016). Related to the influence of quantities purchased, Derqui *et al*. (2016) suggested that inaccurately predicting the requirements, may contribute to the generation of food waste. The demand for extensive menu items may lead to the purchasing of expansive inventories that result in unpopular items not being consumed before they spoil, hence food waste (Charlebois *et al*., 2015).

⇒ *Receiving*

A poorly designed and executed receiving process has an influence on the creation of waste in the kitchen. Charlebois *et al*. (2015) argued that if receivers failed to identify poor quality, damaged or spoiled food products at the time of delivery, the food service unit absorbs the waste instead of returning the products to the supplier. In the same manner, if food products are mishandled and the temperature is not controlled during the receiving process, food may be spoiled and ultimately wasted. Food waste generation under this subsystem remains under-researched.

⇒ *Storage, inventory control and issuing*

Improper storage of received food may lead to deterioration (Betz *et al*., 2015; Engström & Carlsson-Kanyama, 2004; Filimonau & De Coteau, 2019; Thyberg & Tonjes, 2016). When food is left exposed to extremes of temperature and humidity, it may become damaged hence wasted (Payne-Palacio & Theis, 2016: 206). Research by Charlebois *et al*. (2015) and Goh and Jie (2019) showed that failure to follow inventory methods, such as FIFO (First-in, First-out), leads to the use of newer stock, and older stock ends up being wasted. Along the same line, poor stock rotation is a culprit of the generation of food waste (Mena *et al*., 2011). Research on causes of food waste during the issuing component of this subsystem appears to be limited.

⇒ *Preparation and production*

The generation of food waste at this stage depends to a large extent on the intensity of procedures carried out in individual food service units. A food service unit that produces food from ingredients prepared from scratch is likely to produce more food waste from trimmings compared to a food service unit that utilises bought-in or convenience ingredients (Papargyropoulou *et al*., 2016). In several studies, overproduction of food that could not be stored or reused for other dishes has been cited as the main cause of food waste at the production stage (Burton *et al*., 2016; Goonan *et al*., 2014; Heikkilä *et al*., 2016; Kasavan *et al*., 2019; Prescott *et al*., 2019). For example, in a study conducted by Goonan *et al*. (2014), on several occasions one or two full food carts were observed being sent directly to the garbage disposal. Other factors that contribute to food waste during the preparation and production stages include; cross contamination, burning food, improper temperature control and mistakes in the production of food items (Burton *et al*., 2016; Charlebois *et al*., 2015; Marais *et al*., 2017; Prescott *et al*., 2019; Thyberg & Tonjes, 2016).

⇒ *Distribution and service*

During distribution, food waste may be caused by the damage to food as a result of excessive and improper handling (Mena *et al*., 2011). Food waste at this stage may be a result of spillages during transportation of food. Poor quality of food intended for delivery from a central kitchen to satellite units may result in rejection hence food waste (Mena *et al*., 2011). Mena *et al*. (2011) also cited poor temperature control (5ºC - 60ºC) during distribution as a common cause of food waste. The type of service used by a food service unit has an influence on food waste generation. For instance, buffet style service tends to produce substantial amounts of leftovers, making it the most wasteful type of service (Papargyropoulou *et al*., 2016). Rajan *et al*. (2018) showed that at the Canada Green University, the buffet style of service produced significantly more food waste (53%) than an à-la-carte service system. A plated meal service is associated with food waste generation as customers do not have an option to request an adjustment of food portions to suit their preferences (Williams & Walton, 2011). The literature further indicated that portioning practices play a role in food waste generation (Goonan *et al*., 2014; Heikkilä *et al*., 2016; Kasavan *et al*., 2019; Ofei *et al*., 2014; Pinto *et al*., 2018). For example; in a study conducted by Kasavan *et al*. (2019) participants indicated that in their food service operations they provided standard-sized portions, with no customised portions to accommodate customers' appetites, individual preferences nor age, which resulted in substantial plate waste. Oversized portions and inconsistencies while serving are cited as common causes of food waste (Goonan *et al*., 2014; Heikkilä *et al*., 2016; Kasavan *et al*., 2019; Pinto *et al*., 2018).

- *Management functions*

The limited literature on management functions and food waste, links failure to effectively execute management functions to food waste generation (Charlebois *et al*., 2015; Heikkilä *et al*., 2016). 'For example, the management system has a significant effect on how kitchen activities are controlled and regulated and how various practicalities like maintaining and correcting recipes, deciding on amounts of food to be prepared, menu planning and inventories are dealt with.' (Heikkilä *et al*., 2016:449). Failure of management to effectively plan, organise, direct and control these functions as well as support food waste prevention strategies, may result in food wastage (Charlebois *et al*., 2015). The literature further indicated that a poor relationship between management and food service workers was a contributing factor to food waste. For example, in a study conducted by Charlebois *et al*. (2015), it was observed that management directed food service workers inconsistently; some workers were disciplined for being wasteful while others were not. As a result of inconsistent directing by management, those who wasted and did not get punished continued to be wasteful, while those who were punished developed resentment and wasted food for lack of being rewarded for their efforts (Charlebois *et al*., 2015). In relation to this, Heikkilä *et al*. (2010) pointed out that the ability of the manager to motivate, encourage and give instructions had an influence on food waste generation. This implies that in a food service operation where a manager lacks the ability to motivate staff, food waste may be created.

- *Linking processes*

Linking processes; decision-making, communication and balance, have an influence on food waste generation (Betz *et al*., 2015; Charlebois *et al*., 2015; Goonan *et al*., 2014; Halloran *et al*., 2014). According to research, involving food service employees with decision-making, increases their responsibility and owning initiatives to reduce and manage food waste (Goonan *et al*., 2014). Ineffective communication between all levels of food service staff, departments, customers, suppliers and other relevant stakeholders is frequently cited as a contributing factor to food waste (Goonan *et al*., 2015; Goonan *et al*., 2014; Heikkilä *et al*., 2010; Kasavan *et al*., 2019; Ofei *et al*., 2014; Papargyropoulou *et al*., 2016). A study conducted by Ofei *et al*. (2014) and Papargyropoulou *et al*. (2016) revealed that poor interdepartmental communication, regarding changes in meal reservations, between the sales department (in charge of bookings), procurement department (food provisioning), production department (kitchen) and waiting staff, led to food waste. For example, poor communication between the procurement and production departments, such as inventory levels of food items about to expire (Kasavan *et al*., 2019), and failure to address customers' complaints of poor quality products (Heikkilä *et al*., 2010; Sonnino & McWilliam, 2011) led to food waste. Heikkilä *et al*. (2010) further indicated that their findings revealed that without communication between food service operations and suppliers about incorrect or defective deliveries, food waste is generated.

3.3.3.3 Outputs

Quality and quantity of meals, customer (external and internal) satisfaction and financial accountability were important factors in food waste generation (Girotto *et al*., 2015; Lam, 2010; Marais *et al*., 2017; Papargyropoulou *et al*., 2016, Williams & Walton, 2011). The literature showed that poor quality meals (not tasty, over or under-cooked, poor appearance, less varied or not hot or cold enough) result in service and plate waste (Heikkilä *et al*., 2010; Marais *et al*., 2017; Williams & Walton, 2011; Wu *et al*., 2019). Another factor that contributes to the situation is the quantity of the meals. A study conducted by Papargyropoulou *et al*. (2016) revealed that restaurants prepared 30% more food than the required amount for the reservations made. Papargyropoulou *et al*. (2016) added that larger quantities were served in an attempt to meet customer satisfaction and to maintain the display of a buffet service. Several studies clearly indicated that if the meals did not meet customer satisfaction, food was left on the plate and had to be disposed of (Heikkilä *et al*., 2010; Marais *et al*., 2017; Williams & Walton, 2011; Wu *et al*., 2019). Goh and Jie (2019) described customers as demanding and that their negative perception towards re-use of leftovers contributed to food waste. Research showed that employee dissatisfaction can lead to food waste generation. Charlebois *et al*. (2015) indicated that unhappy employees and those with tense relations with management are culprits of food waste generation as they are less motivated to meet organisational goals including the reduction of food waste. With regards to financial accountability, food service employees and managers, who fail to see the cost implications of food waste, may remain wasteful (Goonan *et al*., 2015).

3.3.3.4 Controls

Internal and external controls, which include the menu, standards, policies and procedures, and programmes of the food service system, are an important factor in food waste generation (Gregoire *et al*., 2013:7). The menu as the primary control element has an influence on food waste. The results of the study conducted by Filimonau and De Coteau (2019) revealed that the utilisation of a complex menu with extensive choices and unpopular dishes that do not accommodate customers' needs, leads to food waste. Portioning standards and guidelines also contribute to food waste in two ways. First, failure of food service workers to adhere to portioning standards, often serving bigger portions than set standards, create substantial amounts of food waste (Goonan *et al*., 2014). Second, adherence to standardised portion sizes without customising to the needs of the customers, leads to plate waste generation (Kasavan *et al*., 2019). Despite issues surrounding the provision of larger portion sizes than customers can eat, some food service operations have a 'take away policy' that does not permit customers to take away leftovers, which results in food waste (Goh & Jie, 2019).

Another control element; food safety regulations, have an influence on the creation of food waste, for example; prepared meals can be kept in a bain-marie for a maximum of four hours at 55ºC, after which the food must be disposed of (Heikkilä *et al*., 2010). In a study by Kasavan *et al*. (2019), 10% of food service operations adhered to this policy for safety and hygienic reasons. Additionally, Hennchen (2019) indicated that food safety regulations, which do not permit the re-use of reheated or untouched leftovers on customers' plates, is a contributing factor. Quality requirements obligate food service operations to dispose of leftover food once it has left the kitchen (Betz *et al*., 2015). Other elements, such as aesthetic quality requirements and procurement food specifications that lead to the rejection of imperfect produce and food, have an influence on the creation of food waste (Thyberg & Tonjes, 2016).

3.3.3.5 Memory

The literature indicates that there is a link between the memory element and food waste in the food service system (Betz *et al*., 2015; Ferreira *et al*., 2013; Painter *et al*., 2016), such as inaccurate forecasting (Filimonau & De Coteau, 2019; Goonan *et al*., 2015; Goonan *et al*., 2014; Hennchen, 2019; Ofei *et al*., 2014; Papargyropoulou *et al*., 2016; Pinto *et al*., 2018; Pirani & Arafat, 2014; Thyberg & Tonjes, 2016). In a study conducted by Goonan *et al*. (2015), inaccurate forecasting alone generated the highest volume of food waste rather than storage, preparation and production subsystems. The challenge of planning accurate food quantities is evident right from the procurement stage. Deciding on quantities of food to procure is based on current inventory levels, past records of food orders and anticipated number of customers. However, such records do not always give a true picture, which may lead to overstocking. In situations where not all food is prepared before expiry, it leads to food spoilage during storage (Hennchen, 2019). In some instances, food service operations prepare more food than necessary to avoid running out, or due to their inaccurate forecasting based on manual counting (Goonan *et al*., 2014; Papargyropoulou *et al*., 2016). Meal ordering or having a pre-booking system has been discussed as a non-flexible practice that generates food waste when meals are booked but not taken (Marais *et al*., 2017; Ofei *et al*., 2014; Painter *et al*., 2016). According to Ofei *et al*. (2014), the meal ordering system in a hospital required preparing food-orders a minimum of 3 days in advance, which did not give an accurate number of patients in the ward on the serving day. Predicting the number of customers based on the pre-booking system therefore, proves to be an unreliable method. The review of the literature shows gaps in relating other records of the food service system, such as personnel records and financial records to food waste generation.

3.3.3.6 Feedback

Failure to put feedback mechanisms in place or to respond to the information indicating the necessity to correct errors, may contribute to food waste (Lai & Huili-Lin, 2017). In relation to this, the literature shows that where there is no formalised system for auditing or monitoring food waste, the food waste generation situation remains unknown and this can deprive management of the opportunity to address or reduce food waste (Kasavan, Mohamed & Halim, 2019; Ofei *et al*., 2014). In another study, it was indicated that food waste is recorded but feedback is not shared between site managers and food service personnel, as a result, food service workers do not feel compelled to adhere to prevention practices (Goonan *et al*., 2015). Another element of a feedback mechanism is a meal complaint system, that is, the process used to obtain feedback about meals from customers, which has shown to have an influence on food waste generation. If not effectively implemented, this leads to the provision of meals that do not satisfy customers which led to food waste (Marais *et al*., 2017).

3.3.3.7 Environmental factors

The literature shows that there are internal and external forces that have an influence on food waste generation in the food service system. According to Kasavan *et al*. (2019), food waste under this subsystem can be caused by unsustainable consumption patterns of customers. For example, with a buffet style service, customers are more likely to sample a variety of foods, which end up being left on plates, subsequently producing large volumes of plate waste (Kasavan *et al*., 2019). Similarly, Papargyropoulou *et al*. (2016), and Thyberg and Tonjes (2016) indicated that customers' cultural practices are a factor in food waste generation; for example, where societies have a limited appreciation or place little value on food. Socio-demographic factors, such as age, have been associated with food waste, with the younger generation being the most wasteful (Thyberg & Tonjes, 2016). This indicates the importance of addressing food waste in food service settings with the younger population, such as the university food service units.

Food waste generation has also been linked to the weather, for example, in a study conducted by Prescott *et al*. (2019) they found that in colder weather the number of customers fluctuates, but once winter has passed, the numbers will decrease. During that transition, substantial food waste is created. In a similar way, local events influence food waste generation in that the lack of predictability of the number of customers as a result of such events, may lead to overproduction of food, which ends up being disposed of (Charlebois *et al*., 2015). Another factor is competing food service operators (Derqui *et al*., 2016; Heikkilä *et al*., 2010). In particular, the content and appeal of the competitors' meals influences the number of customers frequenting one's own food service establishment, which often leads to serving-waste (Heikkilä *et al*., 2010).

3.3.4 The importance of food waste prevention

A sound understanding of the importance attached to the prevention or reduction of food waste is a prerequisite to address the development of working solutions. There is a broad consensus that a clear understanding of the implications of food waste alters the perceptions and attitudes of actors towards preventing it (Thyberg & Tonjes, 2016). This section, therefore, reviews the economic, environmental and social benefits of preventing or reducing food waste.

3.3.4.1 Economic benefits of food waste prevention

Preventing food waste has numerous economic benefits. The literature clearly indicates that food waste carries significant economic losses (Lundqvist *et al*., 2008; Nahman *et al*., 2012; Parizeau *et al*., 2015; Pham *et al.,* 2015; Whitehair *et al*., 2013). In South Africa, the total cost of food waste, including disposal costs, and the monetary value lost due to failure to use food waste in other diversion ways, was estimated at R75 billion in 2013 (De Lange & Nahman, 2015). Food service units in universities are equally affected by the economic impact of throwing away food. For example, Painter *et al*. (2016), at Rhodes University in South Africa, estimated the equivalent of US$ 80 000 per annum, was lost to food waste. Reducing food waste benefits food service operators economically in two ways; efficient use of limited resources, thus saving costs embedded within resources, as well as reducing costs linked to food production and disposal of food waste (Papargyropoulou *et al*., 2016).The actual costs that are incurred as a result of food waste can be represented as in Figure 3.10.

FIGURE 3.10: THE ACTUAL COSTS OF FOOD WASTE

3.3.4.2 Environmental benefits of food waste prevention

Food waste is associated with significant environmental impacts, which are dependent on food waste management practices (Thyberg & Tonjes, 2016). As discussed in Chapter 2, Figure 3.11 (next page) shows the options available to prevent and manage food waste. Prevention is the most favourable option and disposal is the least. However, 90% of wasted food ends up at the landfills, which is a significant portion that impacts negatively on the environment (Thi *et al*., 2015). In landfills, food waste, associated with the food supply chain, converts to methane. This is 20% of global greenhouse gas emissions, which contribute to global warming (De Lange & Nahman, 2015; Kallbekken & Sælen, 2013; Scholz, Eriksson & Strid, 2015). In South Africa, organic waste including food waste, contributes 4.3% of the total greenhouse gas emissions (Nahman *et al*., 2012). This figure accounts for the disposal of waste only and does not take into account greenhouse gas emissions resulting from the food product life cycle. Preventing food waste, and diverting it from landfills, has the potential to reduce the environmental effects.

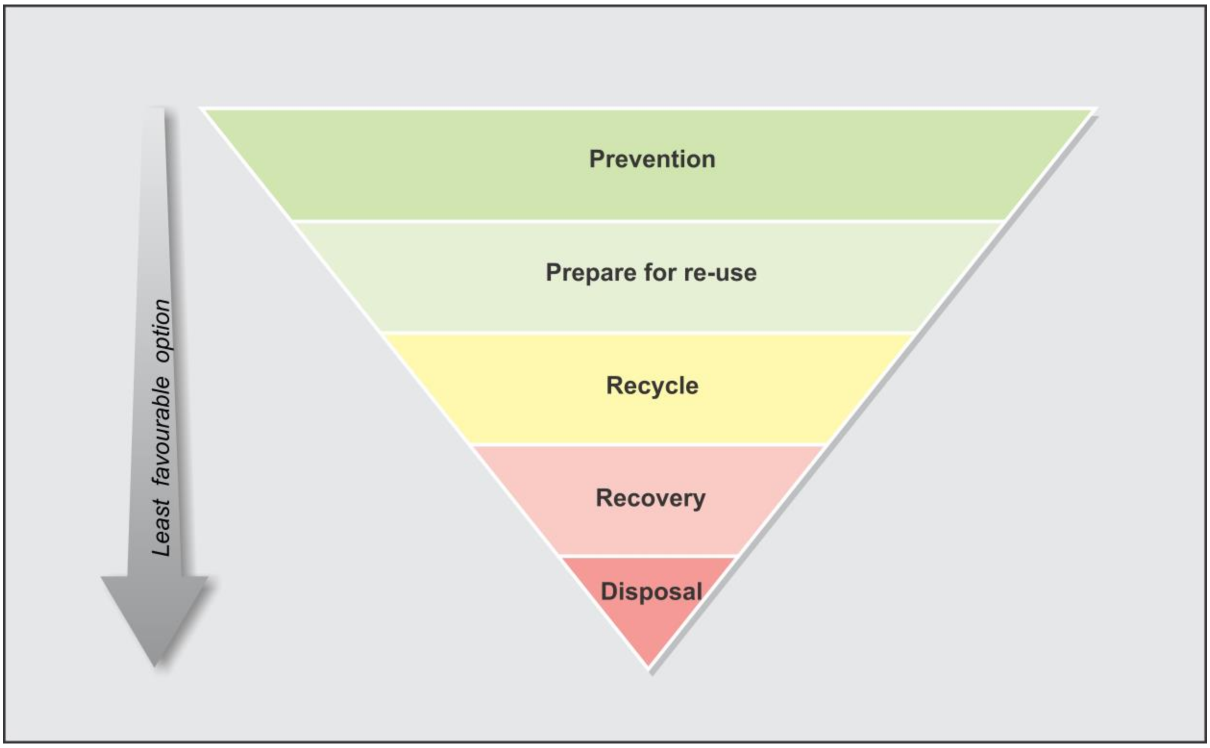


FIGURE 3.11: THE FOOD WASTE MANAGEMENT HIERARCHY *(Papargyropoulou et al., 2014)*

As discussed below, food waste puts pressure on the use of water and energy, therefore, addressing food waste saves these resources.

- *Water*

Studies carried out on the water footprint indicate that a substantial proportion is used throughout the food supply chain (Buzby & Hyman, 2012; Nahman *et al*., 2012; Oelofse & Nahman, 2013; Parizeau *et al*., 2015; Quested *et al*., 2013) resulting in a significant wastage of water. At global level, it is estimated that 306 cubic kilometers of water is wasted on food annually (FAO, 2014). In South Africa, the most recent estimates indicated that the waste of food represents as much as 1.7 cubic kilometers of water wasted throughout the entire food supply chain annually, which is equivalent to a fifth of South Africa's total water withdrawals (WWF, 2017). This represents a significant loss of the scarce resource.

- *Energy*

The waste of food represents a waste of natural resources including energy. In the United States, throughout the food supply chain, the production of food consumes 16% of energy, part of which is lost due to wasted food (Wunderlich & Martinez, 2018). In South Africa, nearly 29 000 million MJ per year of energy is embedded in food waste (Notten, Bole-Rentel & Rambaran, 2014), which is approximately R1 billion per year (WWF, 2017). This analysis provides an important understanding of energy implications of wasted food. Preventing food waste may reduce the use of energy associated with the production of food that ends up being wasted.

3.3.4.3 Social implications of food waste

The interest surrounding the issue of food waste is to some extent driven by its social impacts (Abeliotis *et al*., 2014; Gustavsson *et al*., 2011; Nahman *et al*., 2012; Ofei *et al*., 2014). A large amount of food that is fit for human consumption and which could potentially help feed the world's hungry population, is wasted (Gustavsson *et al*., 2011). It is estimated that one third of food produced globally, which is 1.3 billion tonnes, goes to waste yet almost 1 billion people worldwide are undernourished (Gustavsson *et al*., 2011; WWF, 2017). In South Africa, approximately 26% of households experience hunger, while a further 28.3% are at risk of hunger, yet a substantial amount of food is wasted annually (WWF, 2017).

Perhaps most importantly in the context of universities, some students are food insecure, yet a proportion of edible food is disposed of. At the University of Kwazulu-Natal, a South African institution, a study revealed that 20.8% of the sample experienced food insecurity (Munro, Quayle, Simpson & Barnsley, 2013). Reducing food waste can, therefore, potentially reduce food insecurity (Bond, Meacham, Bhunnoo & Benton*,* 2013; Buzby & Hyman, 2012). Based on this, it is important to develop strategies that can address food waste in university food service units.

3.3.5 Food waste prevention approaches in the food service system

The following section provides a review of approaches to prevent food waste in the food service sector. The review follows a systems approach within the food service system.

3.3.5.1 Inputs

The literature indicates that a number of elements within the inputs subsystem can assist with food waste prevention (Table 3.2). Trained or skilled staff are key to the prevention of food waste, especially production waste. Skilled staff reduce the risk of spoilage and the need to re-produce food items (Papargyropoulou *et al*., 2016). The literature shows that the use of pre-prepared ingredients is an important strategy that significantly eliminates food waste, due to the lack of trimmings (Derqui *et al*., 2016; Goonan *et al*., 2014). However, this approach, which needs to be applied with caution, shifts the responsibility of food waste generation further up the food chain. A study by Heikkilä *et al*. (2016) elucidated that in food production, the use of good quality ingredients was important in minimising the generation of kitchen waste.

TABLE 3.2: FOOD WASTE PREVENTION IN THE INPUTS SUBSYSTEM

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Inputs	Trained and experienced employees	Betz *et al.* (2015); Charlebois *et al*. (2015); Derqui *et al*. (2016); Ferreira *et al.* (2013); Heikkilä *et al.* (2016); Priefer *et al.* (2016); Scotland Resource Efficient (2014); Strotmann, Göbel, Friedrich, Kreyenschmidt, Ritter & Teitscheid (2017); United States Environmental Protection Agency (2014).
	Utilisation of pre-prepared (processed) ingredients	Creedon *et al*. (2010); Derqui *et al*. (2016).
	Use of good quality ingredients	Goonan *et al*. (2014); International Tourism Partnership (2014).
	Sufficiently long mealtimes	Ferreira *et al*. (2013); Heikkilä *et al*. (2016); Ofei *et al*. (2014).

Good quality ingredients produce good quality meals that are suitable for human consumption and reduce the chances of discarding food. Research (Heikkila *et al*., 2016; Silvennoinen *et al*., 2015) illustrated that sufficiently long meal times reduce food waste, as this strategy ensures sufficient time for patrons to order, eat and possibly finish the produced food. Along the same lines, reducing the variety and amount of food offered at the end of service time, plays a critical role in preventing food waste (Betz *et al*., 2015; Derqui *et al*., 2016; Irish Environmental Protection Agency, 2014).

3.3.5.2 Transformation

This subsection reviews food waste prevention approaches that are implemented under the different elements of the transformation subsystem.

- *Functional subsystems*
  - ⇒ *Procurement*

Various approaches have been applied to prevent and reduce food waste at the procurement stage of the food service system. Food service operations develop and adhere to specific standards or food specifications that suppliers have to comply with. Failure to do so, can lead to food being rejected on delivery and avoids food waste being generated by the supplier (Charlebois *et al*., 2015). The literature (Creedon *et al*., 2010; Derqui *et al*., 2016; Pirani & Arafat, 2014) further indicates that sourcing local ingredients ensures that the food service operation receives the freshest ingredients, which reduces the risk of spoilage. Careful consideration needs to be given to food packaging. A suitably sized and designed package ensures complete utilisation of the food product and avoids residual container waste (Heikkilä *et al*., 2016). While not all food is available in suitable package sizes, food service operators can state their specifications of the packaging design and size required. This will assist to minimise food wastage as a result of spoilage of leftover or unused ingredients.

Other commonly applied food waste prevention practices include the avoidance of overstocking, while ordering suitable amounts of food for a given period (Derqui *et al*., 2016; Halloran *et al*., 2014; Heikkila *et al*., 2016; Irish Environmental Protection Agency, 2014). To avoid overstocking, food service operators can establish a system to record what is in stock, what needs to be ordered, and slow-moving ingredients, plus their expiry dates. As the ingredients are used, the stock quantity is reduced and the quantity of what needs to be ordered is altered appropriately (Creedon *et al*., 2010). Additionally, the prevention of food waste at the procurement stage entails purchasing perishable food with a sufficiently long shelf life to avoid food spoilage (Betz *et al*., 2015). The food waste prevention measures that can be taken under the procurement stage are summarised in Table 3.3 below.

TABLE 3.3: FOOD WASTE PREVENTION IN THE PROCUREMENT FUNCTION

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Functional: *Procurement*	Development and adherence to food specifications	Charlebois *et al*. (2015).
	Ordering suitable amounts of food	Derqui *et al*. (2016); Halloran *et al*. (2014); Heikkilä *et al*. (2016); Irish Environmental Protection Agency (2014).
	Sourcing local ingredients	Creedon *et al*. (2010); Derqui *et al*. (2016); Pirani & Arafat (2014).
	Purchasing perishable food with a sufficiently long shelf life	Betz *et al*. (2015); Creedon *et al*. (2010).
	Enhancement of order intervals and no stock buying	Heikkilä *et al*. (2016).
	Package considerations	Heikkilä *et al*. (2016); ReFED (2016).

⇒ *Receiving*

The most common strategy applied at the receiving point to minimise food waste, is to inspect the deliveries to ensure that food is free from contaminants, meets specifications, has not expired and the packaging is not damaged (Charlebois *et al*., 2015; Pirani & Arafat, 2014). Any food product that does not meet the standards is immediately rejected and returned to the supplier to avoid food waste on the part of the food service operator. Upon delivery, all food products are labelled using an easily understandable food labelling system; the label should clearly indicate the expiry date, date of receipt or delivery, product name and storage instructions (Creedon *et al*., 2010). This information will enable food service workers to optimise inventory control thus minimise food spoilage. Once food is delivered and labelled, it is promptly transferred to the storage areas. This is especially critical with perishables and frozen food which are stored in refrigerators and freezers. This must be done in the shortest time possible to prevent food spoilage by maintaining the appropriate temperature (Engström & Carlsson-Kanyama, 2004). Measures to prevent food waste within the receiving function, are tabulated in Table 3.4.

⇒ *Storage, Inventory control and issuing*

A number of strategies to prevent food waste in the food service system, are implemented during storage, inventory control and issuing. Ensuring that food is kept under optimum storage conditions, is a prerequisite to prevent food waste (Beretta, Stoessel, Baier & Hellweg, 2013; Betz *et al*., 2015; Marthinsen, Sundt, Kaysen & Kirkevaag, 2012). It is critical to store food at the correct temperatures and humidity levels to prevent food deterioration (Creedon *et*

TABLE 3.4: FOOD WASTE PREVENTION IN THE RECEIVING FUNCTION

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Functional: *Receiving*	Inspection of food delivered	Charlebois *et al*. (2015); Creedon *et al*. (2010); Pirani & Arafat (2014).
	Date marking all products received	Creedon *et al*. (2010).
	Prompt transfer of food items to appropriate storage areas	Engström & Carlsson-Kanyama (2004).

al., 2010; Derqui *et al*., 2016; Papargyropoulou *et al*., 2016). Adequate storage space is another important aspect of food waste prevention. It allows food service workers to store food appropriately and enables the arrangement of food to allow easy access to food products (Engström & Carlsson-Kanyama, 2004). This helps minimise food wastage that may occur due to spillages, breakages and spoilage.

Storage waste can be minimised by applying the First-In, First-Out (FIFO) approach to ensure that the old stock of food is used before the newly purchased food products (Creedon *et al*., 2010; Derqui *et al*., 2016; Marthinsen *et al*., 2012; Pirani & Arafat, 2016; United States Environmental Protection Agency, 2014). Periodic tracking of expiry dates and the adaptation of menus to use food close to its expiry date, is highly recommended to prevent food waste (Betz *et al*., 2015; Derqui *et al*., 2016; United States Environmental Protection Agency, 2014). To prevent food waste during the process of issuing stock, the storage clerk should control this tightly by complying with the quantities in the production recipe and ordered by the kitchen staff (Kinasz *et al*., 2015). A summary of food waste prevention practices under this function is provided in Table 3.5 (next page).

⇒ *Production*

Food waste at the production stage is minimised by avoiding over-trimming of ingredients, especially bulk meats and whole vegetables (Creedon *et al*., 2010; LeanPath, 2016; Pirani & Arafat, 2014). Where food trimmings occur, food service operators may use these to produce other food items like stock, in order to curb food waste. Other strategies to prevent food waste include the preparation of food-to-order or batch cooking. This is when food, which needs a

TABLE 3.5: FOOD WASTE PREVENTION IN THE STORAGE, INVENTORY CONTROL & ISSUING FUNCTION

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Functional: ***Storage, inventory control & issuing***	Ensure food is stored at optimum storage conditions	Beretta *et al*. (2013); Betz *et al*. (2015); Creedon *et al*. (2010); International Tourism Partnership (2014); Marthinsen *et al*. (2012); Pirani & Arafat (2014); United States Environmental Protection Agency (2014).
	Adequate storage space	Engström & Carlsson-Kanyama (2004).
	Application of the First-In, First-Out (FIFO) stock rotation system	Betz *et al*. (2015); Charlebois *et al.* (2015); Creedon *et al*. (2010); Derqui *et al*. (2016); Goonan *et al*. (2014); International Tourism Partnership (2014); Irish Environmental Protection Agency (2014); Marthinsen *et al*. (2012); Pirani & Arafat (2014); United States Environmental Protection Agency (2014).
	Regular tracking of expiry dates of food items in storage	Betz *et al*. (2015); Derqui *et al*. (2016); United States Environmental Protection Agency (2014).
	A continuous track of inventory levels	Betz *et al*. (2015); Derqui *et al*. (2016); United States Environmental Protection Agency (2014).
	Controlled issuing of food	Kinasz *et al*. (2015).

short preparation time, are prepared as needed during serving time. This allows for greater accuracy and reduces the likelihood of overproduction (Creedon *et al*., 2010; LeanPath, 2016; Marais *et al*., 2017; Marthinsen *et al*., 2012). Table 3.6 shows a summary of food waste prevention strategies during production.

TABLE 3.6: FOOD WASTE PREVENTION IN THE PRODUCTION FUNCTION

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Functional: ***Preparation & Production***	Avoid over-trimming during preparation	Creedon *et al*. (2010); LeanPath (2016); Pirani & Arafat (2014).
	Batch cooking	Creedon *et al*. (2010); LeanPath (2016); Marais *et al*. (2017); Marthinsen *et al*. (2012).

⇒ *Distribution*

Hot and cold holding of food is a critical process in the distribution phase of a food service system. The maintenance of correct temperature during holding of food, contributes to preventing food waste as it conserves the safety of food and avoids food spoilage (Betz *et al*., 2015; Creedon *et al*., 2010; Engström & Carlsson-Kanyama, 2004). In a decentralised delivery-service system, there is a need for improved logistics, such as the use of appropriate equipment that reduces food damage when food is transported from a central kitchen to the satellite kitchens (Thyberg & Tonjes, 2016). Food waste prevention practices within the distribution function are shown in Table 3.7.

TABLE 3.7: FOOD WASTE PREVENTION IN THE DISTRIBUTION FUNCTION

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Functional: ***Distribution***	Maintenance of food temperatures during holding and distribution	Betz *et al*. (2015); Creedon *et al*. (2010); Engström & Carlsson-Kanyama (2004).
	Proper equipment is used for distribution	Thyberg & Tonjes (2016).

⇒ *Service*

To prevent food waste in the food service operation, it is important to regularly monitor and control the temperature of food throughout service by ensuring that the bain-marie, salad buffets, holding cabinets and other service equipment, are at the appropriate temperature (Kinasz *et al*., 2015). According to Betz *et al*. (2015), Heikkila *et al*. (2016) and Ofei *et al*. (2014), attractive meal presentation has a role to play in curbing service waste. Notwithstanding this, LeanPath (2016) suggested that the use of garnishes that are often left uneaten, should be limited to reduce food waste. Interesting presentations can be achieved with creative plating of food of different colours and artistic plating of sauces that do not result in food waste (LeanPath, 2016). In addition, portioning accurately by using standardised serving tools assists in preventing food waste (Kinasz *et al*., 2015; Heikkila *et al*., 2016; Ofei *et al*., 2014). Research by Pirani & Arafat (2014) indicated that food service operators who changed their service style from buffet to a-la-carte experienced a noticeable decrease in food waste. Buffet service is associated with overproduction of food that is not served compared to a-la-carte service (Papargyropoulou *et al*., 2016). To minimise food waste from a buffet service, smaller serving containers can be used and the amount of food served can be limited

(Betz *et al*., 2015). Table 3.8 below gives a summary of food waste prevention strategies within the service function.

TABLE 3.8: FOOD WASTE PREVENTION IN THE SERVICE FUNCTION

Subsystems component	**Food waste prevention practices or strategies**	**Relevant research evidence**
Functional: *Service*	Monitor the food holding temperature	Creedon *et al*. (2010); LeanPath (2016); Pirani & Arafat (2014).
	Attractive meal presentation	Betz *et al*. (2015); Heikkila *et al*. (2016); Ofei *et al*. (2014).
	Limited use of garnishes	LeanPath (2016).
	Control the amount of food placed on serving counters	Betz *et al*. (2015).
	Portioning appropriately according to standardised portioning guides	Heikkilä *et al*. (2016); Ofei *et al*. (2014).

- *Management functions*

According to Heikkila *et al*. (2016), an effective management system has a significant influence on food waste reduction and its prevention (Table 3.9). Additionally, effective management and control of kitchen activities play a role in preventing food waste, such as how various practicalities like maintaining and correcting recipes, deciding on the amount of food to be prepared, menu planning and inventories are dealt with (Heikkila *et al*., 2016).

TABLE 3.9: FOOD WASTE PREVENTION WITHIN THE MANAGEMENT FUNCTIONS

Subsystems component	**Food waste prevention practices or strategies**	**Relevant research evidence**
Functional: *Management*	Effective management system	Heikkilä *et al*. (2016).

- *Linking processes*

Research (Goonan *et al*., 2014; Heikkila *et al*., 2016) illustrated that communication, which is a part of the linking processes, has an influence on food waste. Effective communication with customers, suppliers and all levels of food production workers is necessary for the reduction of food waste throughout the food service system (Heikkila *et al*., 2016; Ofei *et al*., 2014; Ofei *et al*., 2015; Papargyropoulou *et al*., 2016; Strotmann *et al*., 2017). For example, communication between the stock clerk and production team about products that will soon expire, or about stock levels of different ingredients, informs the production personnel when there is a need to alter the menu. This will prevent storage waste (Heikkila *et al*., 2016). Additionally, accurate taking of orders and food ordering appear to contribute toward preventing food waste (Creedon *et al*., 2010). Front-of-house staff, who provide customers with clear descriptions of meal items, take accurate orders, as well as accurately communicate orders to the kitchen staff, minimise order errors thus reducing the risk of food waste. Research further showed that by involving food service people in making decisions, increases their responsibility to reduce food waste (Goonan *et al*., 2014). Food waste prevention practices under linking processes are summarised in Table 3.10.

TABLE 3.10: FOOD WASTE PREVENTION IN THE LINKING PROCESSES FUNCTION

Subsystems component	**Food waste prevention practices or strategies**	**Relevant research evidence**
Functional: ***Linking Processes***	Effective communication across the food service system	Creedon *et al*. (2010); Heikkilä *et al*. (2016); Ofei *et al*. (2015); Papargyropoulou *et al*. (2016); Strotmann *et al*. (2017).
	Employees taking part in decision making	Goonan *et al.* (2014).

3.3.5.3 Outputs

Regarding the outputs of the food service system, good management and use of leftovers play a role in preventing food waste (Betz *et al*., 2015; Engström & Carlsson-Kanyama, 2004) (Table 3.11 – next page). Where food is left over, blast-chilling or rapid cooling is applied. Controlled times and temperatures avoid the multiplication of micro-organisms, thus preventing food spoilage, while the food is appropriately stored for later use (Betz *et al*., 2015).

3.3.5.4 Controls

A number of controls, policies and plans applied throughout the food service system have been identified to provide a positive impact on food waste reduction and its prevention. The literature clearly indicates that flexible menu planning that allows the use of food approaching

TABLE 3.11: FOOD WASTE PREVENTION IN THE OUTPUTS SUBSYSTEM

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Outputs	Management and use of leftovers	Engström & Carlsson-Kanyama (2004); LeanPath (2016); Ofei *et al*. (2015); United States Environmental Protection Agency (2014).

its expiry date, surplus ingredients and utilisation of leftovers can cut food waste (Betz *et al*., 2015; Derqui *et al*., 2016; Heikkila *et al*., 2016; LeanPath, 2016; Marthinsen *et al*., 2012; Pirani and Arafat, 2016; Pirani and Arafat, 2014; United States Environmental Protection Agency, 2014). Additionally Thyberg and Tonjes (2016) argued that a simple, lean menu with fewer options results in easier production and lower food waste. Another control measure is meal auditing, which assists in minimising food waste (Goonan *et al*., 2014). This approach uses a meal quality checklist to inspect a meal and identify areas to be improved.

Other control systems to prevent food waste include stock monitoring and rotation policies, which minimise the risk of food spoilage during storage (Goonan *et al*., 2014; Marthinsen *et al*., 2012; Priefer *et al*., 2016; ReFED, 2016). Moreover, Creedon *et al*. (2010) mentioned the importance of maintaining the appropriate storage temperatures, and ensuring that storage equipment is operating at the required temperature to prevent food spoilage due to microbial growth. Furthermore, the literature indicates that the implementation of a regular cleaning and maintenance programme of all equipment plays a role in food waste prevention (Charlebois *et al*., 2015; Creedon *et al*., 2010). This extends the life of equipment which helps avoid food spoilage that may otherwise be caused by equipment breakdowns (Creedon *et al*., 2010).

Adherence to food safety plans and regulations is critical in food waste prevention as it reduces the risk of discarding food due to failure to observe food safety requirements (Papargyropoulou *et al*., 2016; Priefer *et al*., 2016). Further to that, Goonan *et al*. (2014) showed that the use of standardised recipes reduced the amount of food wasted during food preparation and production as errors were minimised Additionally, the use of portioning guidelines increases accuracy in portion control and prevents service waste (Goonan *et al*., 2014). Another strategy is to continually evaluate and appraise suppliers for such aspects as product quality, timeous delivery and the ability to supply the required volume, all of which directly influence food waste prevention in the food service operation (Charlebois *et al*., 2015). Table 3.12 lists strategies for preventing food waste in the control subsystem.

TABLE 3.12: FOOD WASTE PREVENTION IN THE CONTROL SUBSYSTEM

Subsystems component	**Food waste prevention practices or strategies**	**Relevant research evidence**
Control	Flexible, lean menu	Creedon *et al*. (2010); Pirani & Arafat (2014); LeanPath (2016).
	Meal auditing	Goonan *et al*. (2014); Charlesbois *et al*. (2015).
	Stock monitoring and rotation policies	Creedon *et al*. (2010); Marthinsen *et al*. (2012); Goonan *et al*. (2014); Priefer *et al*. (2016); ReFED (2016).
	Maintaining appropriate storage temperatures	Creedon *et al*. (2010).
	Implementation of a regular cleaning and maintenance programme for equipment	Creedon *et al*. (2010); Charlesbois *et al*. (2015).
	Food safety plans	Creedon *et al*. (2010); Goonan *et al*. (2014); Papargyropoulou *et al.* (2016); Priefer *et al*. (2016).
	Standardised recipes	Goonan *et al*. (2014).
	Portioning guidelines	Goonan *et al*. (2014).
	Continuous supplier evaluation	Charlebois *et al*. (2015).

3.3.5.5 Memory

Accurate forecasting is particularly important in food waste prevention. To achieve this, food service operators use automated forecasting systems, which enables them to accurately predict the number of patrons to serve, thus avoiding food surplus (Papargyropoulou *et al*., 2016). Furthermore, the analysis of statistics or any other records indicating consumption and wastage of meals, is essential as these inform the adjustment of orders, this reduces frequently wasted food (Betz *et al*., 2015; Derqui *et al*., 2016; Ferreira *et al*., 2013; Marais *et* *al*., 2017; Painter *et al*., 2016; Pirani & Arafat, 2016; Priefer *et al*., 2016). Additionally, research shows that a pre-booking system that allows for cancellation before the preparation time, marginally reduces food wastage by having as accurate as possible estimation of the would-be taken meals (Marais *et al*., 2017; Painter *et al*., 2016).

The measures of food waste prevention in the memory subsystem are tabulated in Table 3.13 below.

TABLE 3.13: FOOD WASTE PREVENTION IN THE MEMORY SUBSYSTEM

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Memory	Accurate forecasting	Betz *et al*. (2015); Creedon *et al.* (2010); Engström & Carlsson-Kanyama (2004).
	Meal analysis	Betz *et al*. (2015); Derqui *et al*. (2016); Ferreira *et al*. (2013); Marais *et al*. (2017); Painter *et al.* (2016); Pirani & Arafat (2016).
	Pre-booking system that allows cancellation before preparation time	Marais *et al*. (2017); Painter *et al*. (2016).

3.3.5.6 Feedback

Food waste tracking (auditing) and analytics is an important strategy in the minimisation of food waste generation (Burton *et al*., 2016). A study conducted by Burton *et al*. (2016) indicated that tracking food waste makes food service staff aware of the amount of food waste generated, so they can correct their actions to minimise wastage. Feedback from food waste audits should be shared with all role players who are in a position to take appropriate corrective measures (Marais *et al*., 2017). According to Ofei *et al*. (2014), recent advances in technological innovations, such as computerised weighing scales with scanners, and digital cameras, enables food service staff to easily capture food waste data for routine monitoring and reduction. Another strategy, a mechanism for customer feedback can be implemented to obtain relevant information from all stakeholders about the food service system. This can inform management about areas that need to be addressed to reduce or prevent food waste (Marais *et al*., 2017). Table 3.14 (next page) gives a summary of food waste prevention practices in the feedback subsystem.

TABLE 3.14: FOOD WASTE PREVENTION IN THE FEEDBACK SUBSYSTEM

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Feedback	Food waste tracking	Burton *et al*. (2016); Creedon *et al*. (2010); Ofei *et al*. (2014); LeanPath (2016); Priefer *et al*. (2016); ReFED (2016); Silvennoinen *et al*. (2015); United States Environmental Protection Agency (2014).
	Customer feedback	Marais *et al*. (2017).

3.3.5.7 Environmental factors

Food waste can be prevented by policies, laws and regulations made by external regulatory bodies, which affect practices within food service operations. According to Thyberg and Tonjes (2016), policies can be passed to reduce food waste; for example, legislation to ban landfilling with food waste can be introduced. Taxes and fees on waste treatment can be sanctioned or mandated as monetary incentives. Alternatively higher costs for waste disposal can be applied to encourage food waste reduction (Thyberg & Tonjes, 2016). Table 3.15 below shows the food waste prevention strategies in the environmental subsystem.

TABLE 3.15: FOOD WASTE PREVENTION IN THE ENVIRONMENTAL FACTORS SUBSYSTEM

Subsystems component	Food waste prevention practices or strategies	Relevant research evidence
Environmental factors	Taxes and fees on waste management	Priefer *et al*. (2016); Thyberg & Tonjes (2016).
	Legislation to ban landfilling with food waste	Thyberg & Tonjes (2016).

In the following section, another important construct of the study; total quality management is discussed.

3.4 TOTAL QUALITY MANAGEMENT (TQM) PRACTICES

The next section defines the concept of total quality management (TQM), discusses its historical background, its current status in the food service sector, components of total quality management and TQM practices.

3.4.1 What is total quality management (TQM)?

Total quality management (TQM) is defined as a management process with a set of practices that are coordinated to ensure that the organisation consistently meets or exceeds quality standards set by customers and other stakeholders (Jaca & Psomas, 2015; Payne-Palacio & Theis, 2016:428). According to Talib, Rahman and Qureshi (2013:270), 'TQM is a set of management practices applicable throughout the organisation and geared to ensure the organisation consistently meets or exceeds customer requirements.' Baird, Jia Hu & Reeve (2011:789-790) described TQM as '…an integrative organisational-wide philosophy aimed towards continuously improving the quality of products or services and processes in order to meet or exceed customer expectations'. Kim, Kumar & Kumar, (2012: 296) defined TQM as '…a holistic management philosophy that fosters all functions of an organisation through continuing improvement and organisational change'. In the context of the study, total quality management was conceptualised as a set of practices applicable throughout the functions and processes of the food service system to consistently meet or exceed the quality standards of products and services offered.

3.4.2 Historical background of the TQM approach

Different contributors are credited for the development and evolution of the TQM concept and this includes; Edwards Deming, Joseph Juran, Philip Crosby, Genichi Taguchi, Kaoru Ishikawa, Armand Feigenbaum, Myron Tribus, Joyce Orsini, Gipsie Ranney, Brian Joiner, Peter Scholtes and Walter Shewhart (Petersen, 1999). The origins of the TQM approach date back to the 1920s when Dr Walter A. Shewhart developed the statistical process control for the management of quality (Flood, 1993:13). In 1949, after World War II, the Union of Japanese Scientists and Engineers (JUSE) formed a committee of scholars, scientists and industrialists devoted to improving Japanese productivity and heightening their quality of life, (Powell, 1995). The JUSE invited W. Edwards Deming to teach business leaders about his quality management thories, and he developed and taught a course on statistical quality control for Japanese engineers (Richardson, 1997:8). This was followed by the development and widespread dissemination of Deming's 14 points philosophy of TQM (Powell, 1995). Ichiro

Ishikawa, who was the president of JUSE, has also been credited with pioneering Japan's quality movement and developing the quality tool – Ishikawa diagram (Richardson, 1997:8). By the 1970s, the Japanese had mastered achieving quality in their manufacturing sector and had developed a number of quality techniques such as quality circles, supplier partnerships, just-in-time production and hoshin planning (Flood, 1993).

In the 1970s, the Americans started feeling the pressure when some USA policy observers warned that Japanese manufacturing quality far surpassed that of America (Powell, 1995). As a result, a considerable market share was lost to higher quality Japanese producers and the Americans started adopting and applying some quality philosophies, principles and methods. To date, the TQM approach is popular and widely applied across different organisations. Figure 3.12 gives a summary of the total quality management movement.

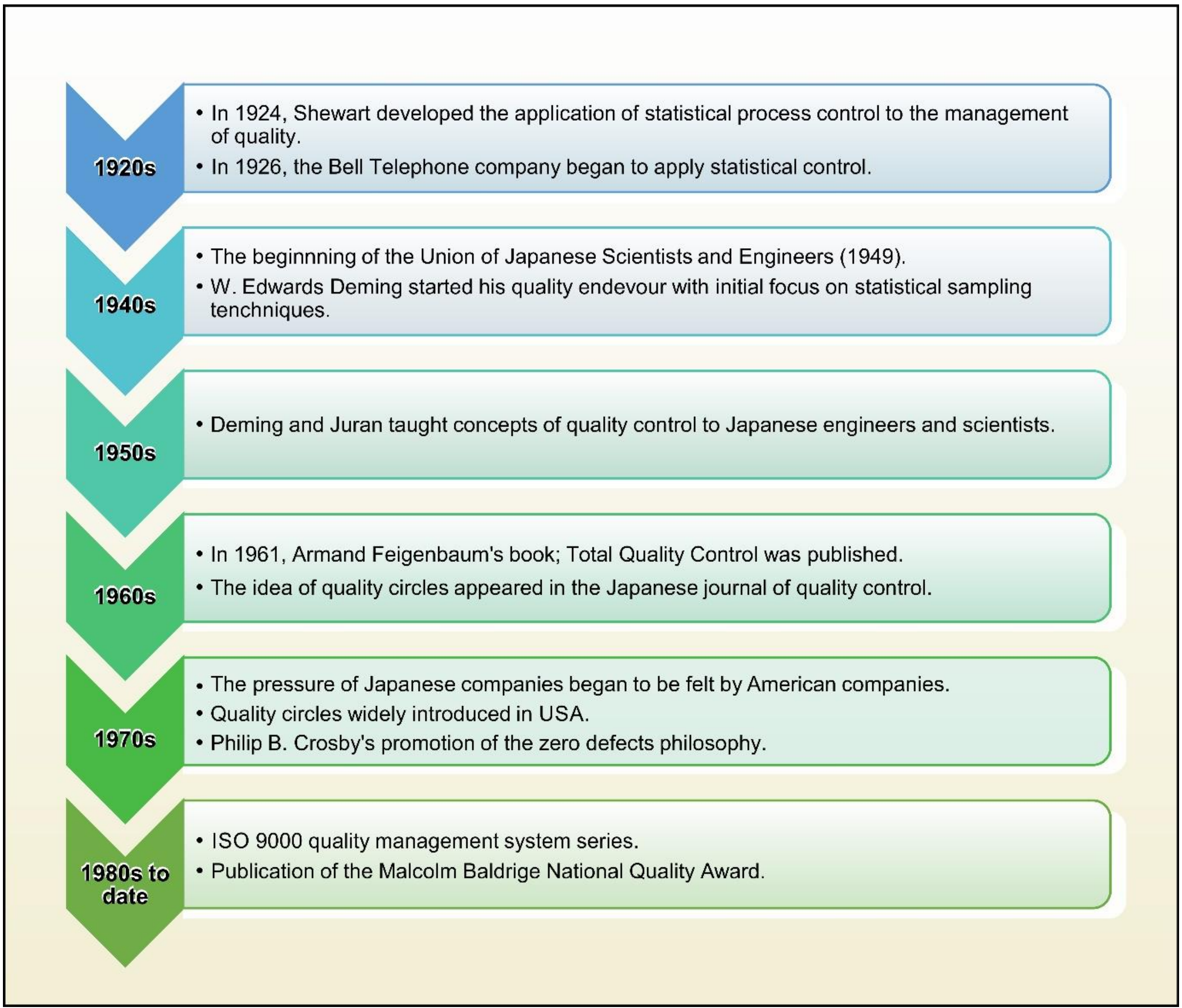


FIGURE 3.12: HISTORICAL DEVELOPMENT OF THE TQM APPROACH (Adapted from Martinez-Lorente, Dewhurst & Dale, 1998:382)

3.4.3 Current status of TQM in the food service sector

The application of TQM practices has been embraced by many firms around the world since the 1980s, especially in industrialised countries, following its successful implementation by Japanese companies (Psomas & Fotopoulos, 2010; Samson & Terziovski, 1999; Yong & Wilkinson, 2001). Since inception, the application of TQM practices has been a matter of great interest in the manufacturing industry (Sureshchandar *et al*., 2001). The examination of scholarly research shows little work with regards to the application of TQM practices in the food service sector, specifically the catering segment. Morath and Doluschitz (2009) conducted a study to analyse the application of the TQM approach by different companies in the food industry. The study focused on food manufacturing companies that produce, process and preserve food products. The application of TQM in food service operations is limited.

Psomas and Fotopoulos (2010) conducted a study to examine TQM practices implemented by food companies, and the benefits achieved through the implementation of such an approach. An attempt was made by them to sample companies from the food service segment but the nature of such companies and the service provided, was not clearly defined. Additionally, the sample was predominantly from the food manufacturing sector, with only 8% of the sample being food service. The analysis of the study results revealed four dimensions of TQM practices applied in the food companies, namely; quality practices of top management, customer focus, employee involvement, and process and quality management. A study by Beardsell and Dale (1999) assessed the relevance of TQM in the food supply and distribution industry, and confirmed its applicability. The results, however, were limited to findings of two cases of food supply and distribution companies, and may not have applied to food service units. This study, therefore, seeks to close this gap by developing a TQM tool applicable to the food service sector.

3.4.4 Components of total quality management (TQM)

As illustrated in Figure 3.13, TQM is viewed as a management system consisting of three components; practices (values or principles), techniques, and tools (Hansson, 2003).

The implementation of TQM practices is supported by techniques and quality tools. In this study, the focus is on addressing food waste in food service operations through the implementation of a set of TQM practices. These are elaborated on in the next section.

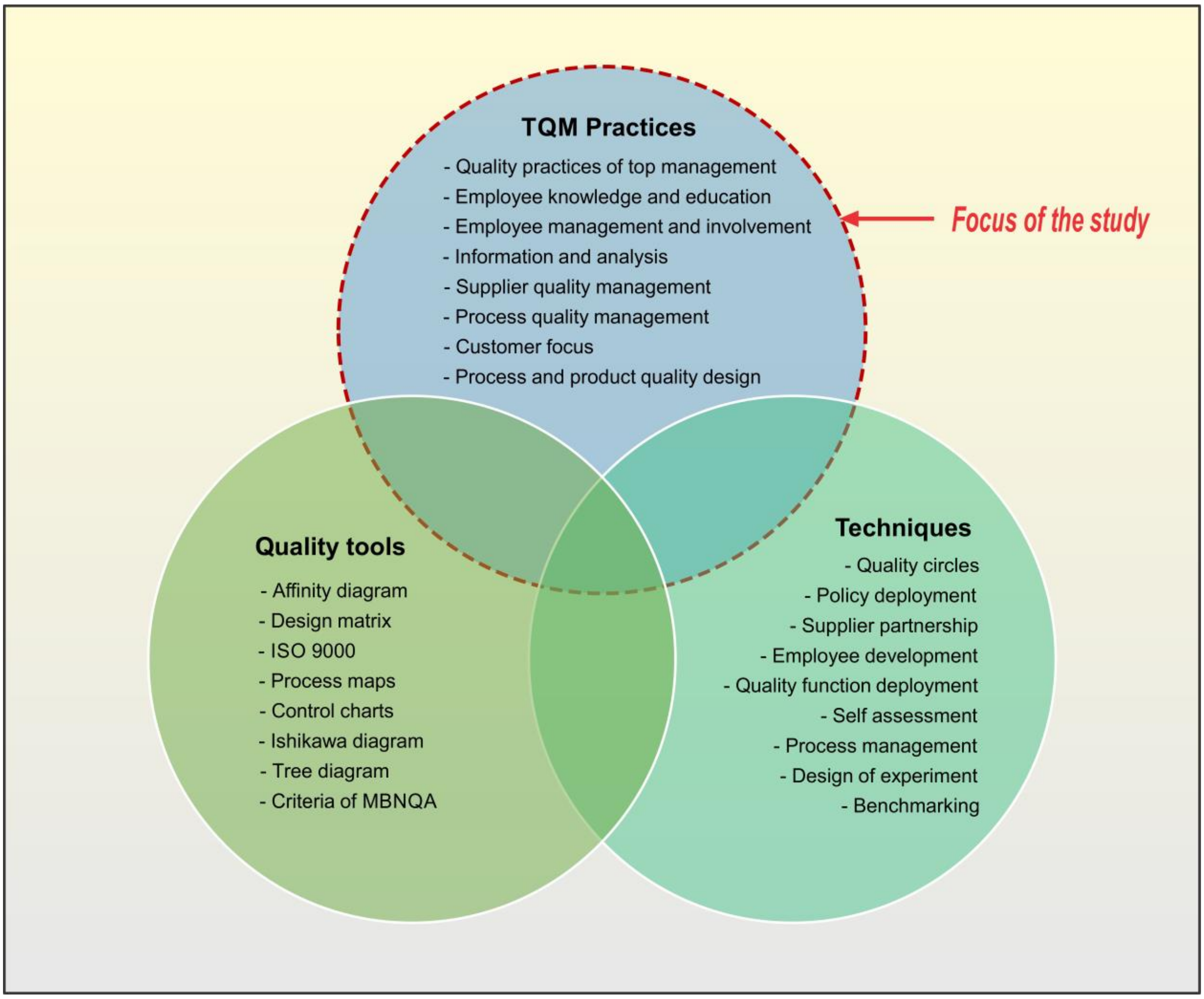


FIGURE 3.13: COMPONENTS OF TOTAL QUALITY MANAGEMENT (Adapted from Hansson, 2003:11)

3.4.5 Total quality management (TQM) practices

After an extensive review of the literature, the TQM practices that are frequently cited in the literature (Agus, 2001; Aquilani, Silvestri, Ruggieri & Gatti, 2017; Bouranta, Psomas & Pantouvakis, 2017; Fotopoulos, Psomas & Vouzas, 2010; Jaca & Psomas, 2015; Honarpour, Jusoh & Long, 2017; Kim *et al*., 2012; Prajogo & Sohal, 2003; Sadikoglu & Zehir, 2010) and are thus considered in this study as follows:

1. Quality practices of top management;
2. Employee knowledge and education;
3. Employee management and involvement;
4. Information and analysis;
5. Supplier quality management;
6. Process quality management;
7. Customer focus; and
8. Process and product quality design.

Although not exhaustive, these practices have often been considered the critical factors of TQM. Table 3.16 summarises the results of the review on TQM practices and further lists indicators of each of the dimensions of total quality management.

TABLE 3.16: MAJOR TQM PRACTICES EXTRACTED FROM THE LITERATURE

TQM Practices	Authors or Sources
Quality practices of top management - Management actively participates in quality management efforts. - Management holds regular meetings to discuss quality related issues. - Management supports quality improvement efforts by providing the necessary resources. - The quality policy is taken into consideration in strategic planning. - Quality data is taken into consideration in decision making. - The quality policy is communicated throughout the company. - Top management gives employees the authority to manage quality problems. - Management sets quality strategies for employees. - Quality results are evaluated to check improvements. - Management gives priority to production processes.	Bouranta *et al*. (2017); Jaca and Psomas (2015); Li, Anderson & Harrison (2003); Psomas and Fotopoulos (2010); Qasrawi, Almahamid & Qasrawi (2017); Sadikoglu and Olcay (2014), Tarí, Molina & Castejon (2007).
Employee knowledge and education - Educational programmes are evaluated. - Employees are trained in subjects with regard to their speciality and daily work. - Employees have knowledge and know-how. - Employees are educated in quality management techniques. - Resources are provided for staff training.	Bouranta *et al*. (2017); Jaca and Psomas (2015); Psomas, Vouzas, Bouranta & Tasiou (2017).
Employee management and involvement - Employees who improve quality are rewarded. - Employees are evaluated. - Employees participate in quality improvement activities e.g. decision-making, setting quality objectives. - Employees take initiatives. - Employees recognise superior quality performance. - Employees are motivated to improve their performance.	Bouranta *et al*. (2017); Jaca and Psomas (2015); Li *et al*. (2003); Psomas *et al*. (2017); Psomas and Fotopoulos (2010); Quazi, Hong & Meng (2002); Sadikoglu and Olcay (2014).
Information and analysis - A variety of data collection methods are used to ensure reliability of quality - performance data. - There is adequate storage for archiving of information. - Easy retrieval of stored information - Systematic analysis of data.	Anil and Satish (2015); Fening, Pesakovic & Amaria (2008); Kaynak (2003); Quazi *et al*. (2002); Rahman (2001); Sadikoglu and Zehir (2010).
Supplier quality management - There is a solid partnership with suppliers. - The specifications are clearly determined by the organisation to suppliers. - Quality audits are implemented by the organisation's representatives at the suppliers' site. - Suppliers selected on quality rather than price or schedule.	Kim *et al*. (2012); Li *et al*. (2003); Psomas *et al*. (2017); Talib *et al* (2013).
Process quality management - Process non-conformities are detected through internal audits. - Critical processes are determined and evaluated. - Determination of areas, processes and points for improvement. - Specific organisational structures have been formulated to support quality improvement. - All employees are provided with instructions. - Mistakes are precluded in the process design. - Setting ranges within which non-conformities are allowed.	Jaca and Psomas (2015); Kaynak (2003); Psomas *et al*. (2017; Sadikoglu and Olcay (2014).
Customer focus - There is a documented process of collecting customer feedback. - Customers are encouraged to submit complaints and proposals for quality improvement. - Customer complaints and proposals for quality improvement are selected. - The organisation's managers and employees are in close contact with the customers. - Customers' needs, requirements and desires are recorded and analysed.	Bouranta *et al*. (2017); Jaca and Psomas (2015); Li *et al*. (2003); Nawelwa, Sichinsambwe & Mwanza (2015); Psomas *et al*. (2017); Psomas and Fotopoulos (2010); Qasrawi *et al*. (2017); Sadikoglu and Olcay (2014); Talib *et al*. (2013); Tari *et al*. (2007).
Process and product quality design *(There is lack of evidence of these practices in the literature)*	

The next section explains each of the above tabulated TQM practices.

3.4.5.1 Quality practices of top management

The literature indicates that top management is the key driver in TQM implementation and its performance significantly influences the success of TQM practices (Jung & Wang, 2006; Kaynak, 2003; Kim *et al*., 2012). Effective management provides the necessary resources and removes barriers to enable successful implementation of TQM practices (Mosadeghrad, 2014). According to Sadikoglu and Zehir (2010), when top management is fully committed, it can organise people, processes and activities to achieve set goals of the organisation. Successful implementation of TQM requires a change in organisational culture, which is almost impossible without management's efforts (Kaynak, 2003). Top management has the responsibility to establish quality goals and strategies, discuss quality issues in staff meetings and evaluate quality performance (Kaynak 2003). The commitment of top management to quality practices increases employees' awareness of quality activities hence the effective adoption and implementation of TQM practices (Sadikoglu & Zehir, 2010). Without the support and commitment of top management it may be challenging to implement the TQM approach and produce benefits of other TQM practices (Kim *et al*., 2012).

3.4.5.2 Employee knowledge and education

The main issue addressed in this dimension is how well employees are capacitated or trained to execute the work they are assigned. According to Li *et al*. (2003) and Talib *et al*. (2013), every employee in the organisation should have quality training on specific work skills. A well-trained employee works more efficiently and effectively towards accomplishment of organisational goals and objectives (Kim *et al*., 2012). Mosadeghrad (2014) argued that employee training enhances workforce knowledge and skills, minimises employees' errors and the need for reproduction of faulty products, improves teamwork, helps decrease employees' resistance to organisational change, and enhances job satisfaction. Training can transform employees into creative problem-solvers, who are able to take initiative during work processes, and solve problems that would affect the quality of products (Kaynak, 2003). Continuous training that includes quality control processes and techniques provides sustainability of quality management in an organisation (Sadikoglu & Zehir, 2010; Talib *et al*., 2013).

3.4.5.3 Employee management and involvement

The emphasis of this dimension is on how people are encouraged and enabled to contribute towards quality management, and achieve the organisational goals and objectives (Rahman, 2001). Employee management and involvement must be supported by evaluating the performance of employees, motivating them to improve their performance and rewarding them for significant efforts made in quality improvement (Bouranta *et al*., 2017; Jaca & Psomas, 2015; Psomas *et al*., 2017; Talib *et al*., 2013). The organisation should encourage employees to participate in the decision-making process, setting quality objectives and suggesting improvements (Bouranta *et al*., 2017; Jaca & Psomas, 2015; Li *et al*., 2003; Psomas *et al*., 2017; Psomas & Fotopoulos, 2010; Quazi *et al*., 2002; Sadikoglu & Olcay, 2014). According to Sadikoglu and Zehir (2010), employee management and involvement is an important aspect that can significantly contribute to quality improvement and foreseeing problems in production, which can be counteracted before production errors occur. 'Empowered employees understand the ways that products and services are designed and improved, and they may discover new ways that products and services could increase customer satisfaction.' (Kim *et al*., 2012:299). Further, an empowered employee is positively associated with effective collection, measurement and analysis of data which has a bearing on quality performance and waste reduction (Kim *et al*., 2012).

3.4.5.4 Information and analysis

This dimension refers to the systematic recording and analysis of organisational data (Psomas & Fotopoulos, 2010). Organisations collect, analyse and review data and information to achieve strategic goals and to anticipate and respond to any organisational or external changes (Sadikoglu & Zehir, 2010). Organisational decisions are based on the analysis of relevant data and information (Sadikoglu & Zehir, 2010). For example, data on the rate of defects, defective products and non-conformities can inform employees about changes occurring in production processes, so that corrective actions can be taken (Kaynak, 2003). In this way, waste generation may be reduced. In a total quality management setting, data and information from all functions, processes and key users is timeously shared to improve organisational efficiency and effectiveness (Sadikoglu & Zehir, 2010).

3.4.5.5 Supplier quality management

Supplier quality management refers to the extent to which an organisation depends on its suppliers, is interdependent with suppliers, and works together with them to continuously improve quality (Kim *et al*., 2012). Effective supplier quality management is facilitated by close, cooperative and long-term relationships with suppliers to obtain quality raw materials (Sadikoglu & Olcay, 2014). Developing strategic alliances with suppliers helps organisations take advantage of suppliers' capabilities and expertise as they can suggest the best quality and most efficient raw materials that the organisation can procure (Kaynak, 2003). Effective supplier quality management implies that buyers can pay close attention to each supplier, thereby ensuring timeous delivery of reliable and high-quality products (Kaynak, 2003).

3.4.5.6 Process quality management

Process quality management emphasises taking a preventative and proactive approach to quality improvement, which entails designing processes that are fool-proof (Kaynak, 2003; Sadikoglu & Zehir, 2010). The focus is on building quality, reducing process variation and stabilising production, which results in increased product output, reduced rework and waste, as quality problems are identified and rectified immediately (Kaynak, 2003). This category involves regular preventative maintenance of equipment, which contributes to improved product quality as a result of increased machine reliability and reduced interruptions during production (Kaynak, 2003; Psomas *et al*., 2017). Internal audits that are applied to detect process non-conformities, provision of comprehensive work instructions to employees and determination of critical processes are some of the strategies implemented to improve product quality and, in turn, reduce the need for rework and waste (Jaca & Psomas, 2015; Kaynak, 2003; Psomas *et al*., 2018; Sadikoglu & Zehir, 2010).

3.4.5.7 Customer focus

Customer focus refers to the extent to which an organisation seeks to understand its customers' needs to produce and deliver products and services that fulfil or exceed customers' expectations (Sureshchandar *et al*., 2010). Responding to customers' expectations can possibly decrease the level of the rejection of products hence prevent waste (Sadikoglu & Zehir, 2010). In a total quality setting, close contact with customers is maintained to keep track of their changing needs and align production with their requirements (Bouranta *et al*., 2017; Jaca & Psomas, 2015; Sadikoglu & Olcay, 2014; Talib *et al*., 2007). Internal customers (employees) are also important in the total quality management approach. Their satisfaction, level of efficiency, as well as feedback influences the quality of products and services (Sadikoglu & Zehir, 2010).

3.4.5.8 Process and product quality design

Process and product quality design refers to the extent to which an organisation performs activities and processes geared towards producing and delivering good quality products and services (Talib *et al*., 2013). This dimension involves the unique combination of production and supporting processes meant to produce quality products and services (Li *et al*., 2002).

3.4.6 Total quality management (TQM) practices and food waste

Much attention in the literature has been devoted to examining the relationship between total quality management practices and performance (Agus & Hassan, 2011; Kaynak, 2003; Patiar *et al*., 2012; Sadikoglu & Olcay 2014; Topalović, 2015), total quality management practices and innovation (Kim *et al*., 2012; Prajogo & Sohal, 2003) as well as total quality management and customer satisfaction (Kristianto *et al*., 2012; Mehra & Ranganathan, 2008; Topalović, 2015). Little attention has been given to examining the influence of TQM practices on food waste generation.

The limited literature available shows that TQM's impact on waste generation has been investigated in other contexts but to a lesser extent in the catering sector. Askarian *et al*. (2010) applied a total quality management approach to healthcare waste management in an Iranian hospital. The results of this study indicated a 26% reduction in medical waste after implementation of the TQM approach to waste management (Askarian *et al*., 2010). Generally, empirical findings support the proposition that TQM is positively linked to overall waste reduction, by preventing errors and eliminating the need for inspection, thus reducing the need for the reproduction of products (Rawlins, 2008). Given the current lack of information of the influence of TQM practices on food waste, the study will close the existing research gap and make a valuable contribution to the literature.

In the next section, the construct of sustainability practices in the context of this study is discussed.

3.5 SUSTAINABILITY PRACTICES IN THE CONTEXT OF FOOD SERVICE OPERATIONS

This section defines the concept of sustainability and discusses sustainability practices.

3.5.1 Conceptualisation of sustainability in food service

Although there is growing awareness and attention on sustainability (Pinard *et al*., 2014, there is no universal or agreed definition of sustainability. Various scholars defined sustainability differently; some solely from an environmental perspective, with others drawing economical and or societal implications (Lehtinen, 2012). The High Level Panel of Experts on food security and nutrition (HLPE) defined sustainability as it related to the food system as; delivering food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (Food and Agriculture Organization, 2014). DiPietro, Cao & Partlow (2013) referred to sustainability as green practices and defined this as actions taken to produce food products and services in an environmentally and ecologically friendly way. According to Wang *et al*. (2013), the definition of sustainability or green practices is dependent on the primary goal of the investigator. In the context of this study, sustainability is defined as actions taken to ensure that the processes and activities in the food service system are carried out in a manner that uses resources efficiently, minimises environmental harm and reduces food waste.

3.5.2 Sustainability practices in food service operations

Empirical research on sustainable food systems has largely focused on agricultural food production practices and rarely addressed sustainability in food service units and its potential impact on food waste. The limited literature available on sustainability in the context of food service operations has no clear focus on integrating sustainable practices in the food service system in a way that also leads to the reduction of food waste (Bloemhof *et al*., 2015; Dauner *et al.,* 2011; TRSA, 2014). Sustainable practices have different dimensions. Generally, the literature focuses on three major dimensions; economic sustainability, environmental sustainability, and social sustainability (Gimenez & Tachizawa, 2012; Lehtinen, 2012; Risku-Norja & Muukka, 2013; Shokri *et al*., 2014). A study by Wang *et al*. (2013) categorised sustainability practices into three dimensions being; food materials, environmental and people focused dimensions. For the purpose of this study, the focus was on the sustainable food practices and environmental sustainability dimensions. The specific indicators of sustainability considered in the study are represented in Figure 3.14. It is important to examine sustainability practices in each of these dimensions as they are likely to influence food waste generation.

3.5.2.1 Environmental sustainability

In this study, environmental sustainability was defined as the adoption of practices in relation to equipment usage, water and energy consumption, transport logistics and the kitchen environment, which lower the environmental risk of food service operations and raise ecological efficiency. From the review of the literature, the following are indicated as relevant practices under this dimension (Akkerman *et al*., 2010; Baldwin *et al*., 2011; Green Restaurant Association, 2015; Pinard *et al*., 2014; Shokri *et al*., 2014; TRSA, 2014; Wang *et al*., 2013).

in food service units. Practices related to the economic and social aspect of sustainability were not within the scope of this study.

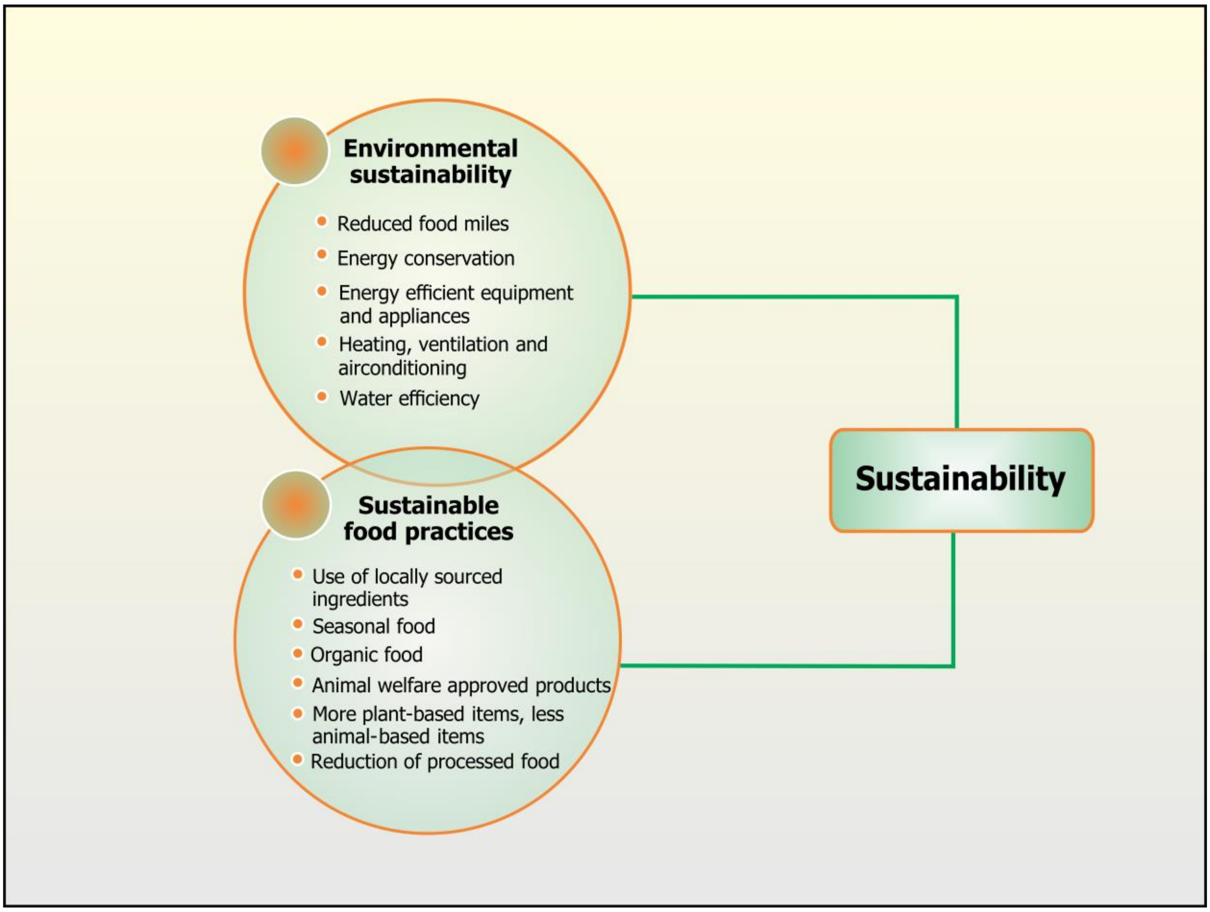


FIGURE 3.14: SCHEMATIC REPRESENTATION OF SUSTAINABILITY IN FOOD SERVICE OPERATIONS

- *Reduced food miles*

Reduced food miles are an important aspect of sustainable food provision. According to Macdiamird (2013), short food supply chains often have a reduced impact on the environment. Some food products like fruits and vegetables, have a short shelf life therefore, when transported from distant locations they may require distribution through long-haul cargo plane, which needs more operational energy and has a negative environmental impact (Morawicki & González, 2018). On the waste management aspect, produce or food purchased that was transported over a short distance, retains food quality better than over long distances (Frash, DiPietro & Smith, 2015; Pearson, Henryks & Jones, 2011). Stagl (2002) indicated that food, especially agricultural produce, easily spoils and can only be stored for a very short period of time. Food transported from beyond regional or national boundaries may therefore, have a shorter life span in the food service operation than food sourced within reduced food miles, thus contributing to food waste.

- *Energy conservation*

Food service operations are considered the most intensive energy users in the commercial sector (Baldwin *et al*., 2011). In the USA, a study commissioned by the United States Environmental Protection Agency in 2009, estimated that cooking in food service operations consumed about 35% energy, of which 28% was used for heating, ventilation and conditioning, 18% for dishwashing, 13% for lighting and six percent for refrigeration (Baldwin *et al*., 2011). The range of electricity consumption may vary from one food service operation to another but the general impression is that cooking consumes the most energy. Energy conservation during cooking is therefore, an important practice with the potential to reduce energy consumption in food service operations. Energy conservation during cooking begins with identifying energy consumption hotspots, energy-use planning such as switching off cooking hoods and equipment when not in use, batch cooking and the adoption of less energy consumption methods, such as blanching, steaming or even cold salad preparation (Vu, Chan, Lim & Chiu, 2017; Wang *et al*., 2013). It is argued that a reduction in energy-demand has the potential to decrease the environmental impact of an operation, for example seven percent reduction in energy-use can reduce the impact on climatic change by 20%, the impact on the ozone layer by 18%, the usage of minerals and fossil fuels will decrease by 66% and 24% respectively (Baldwin *et al*., 2011). This study sought to explore the potential for energy conservation measures in food service operations to reduce food waste. This area has not been investigated through empirical research.

- *Energy efficient kitchen equipment and appliances*

In line with careful energy management, use of energy-efficient kitchen equipment and appliances can substantially reduce the amount of energy consumed by food service operations. A study conducted by Shokri *et al*. (2014) indicated that the majority of food service operators fail to regularly monitor and maintain equipment and appliances, which may lead to increased energy consumption. To improve operational efficiency and ultimately reduce energy consumption, it is recommended that equipment be maintained on a regular basis by repairing leaking and cleaning clogged gaskets, ensuring oven hinges are tight and recalibrating equipment (Lewis, Elmualim & Riley, 2011). From the literature, what remains unknown is whether efficient kitchen equipment and appliances play a role in reducing food waste in food service operations.

- *Heating, ventilation and air conditioning (HVAC)*

In a typical food service operation, heating, ventilation and air conditioning systems account for nearly a third of the total energy consumption (National Restaurant Association, 2018). A proper HVAC system is important in a sustainable food service operation. According to Baldwin *et al*. (2011), proper maintenance of heating, ventilation and air conditioning systems can reduce energy consumption in the food service operation by approximately 15-20%. To reduce energy consumption, Lewis *et al.* (2011) recommended controlling the HVAC system through programmable thermostats, selecting properly designed kitchen exhaust hoods that meet the requirements of the facility and the use of variable speed drives to manually control fan speeds for ventilation hoods. On the part of the HVAC system and food waste generation, no study has investigated this area.

- *Water efficiency*

Food service establishments are among the operations that use a large amount of water for their daily processes. According to a report by the United States Environmental Protection Agency (2012), water used in hospitality and food service operations accounts for about 15% of the total water usage of commercial establishments in the USA. In the context of South Africa, no study has been conducted to indicate water consumption in food service operations. However, the need to save water in the light of the world's water shortage crisis, is a critical component of sustainability. Water efficient practices include examples, such as the installation of water efficient fixtures and equipment like low-flow fixtures, spray nozzles, the replacement of existing water-intensive equipment with improved water efficient models as well as turning off taps when not in use (EPA, 2012; Peregrin, 2011; Wang *et al*., 2013). It is suggested that implementing water efficient practices can decrease water usage by approximately 15%. A decrease in water usage is directly associated with a decrease in energy consumption (EPA, 2012). There is a gap in the understanding of water efficient practices related to the reduction of food waste generation. The study sought to address this gap.

3.5.2.2 Sustainable food practices

In line with the definition adopted by Pinard *et al*. (2014), the study defined sustainable food practices as actions related to food that are taken by the food service operation to minimise harm to the environment and reduce food waste. The following section lists and discusses sustainable food practices that were reviewed in the literature.

- *Use of locally sourced ingredients*

According to Lehtinen (2012), the local food market with relatively short distances between the producer or supplier and the end user – or food miles - is considered a sustainable option for the globalised food market. There is no universally agreed definition for food termed as locally sourced. The most commonly used approach defines local food with consideration to the geographical boundaries and the distance food travels from the producer to the food service operation where the food is sold and consumed (Pearson *et al*., 2011; Weber & Matthews, 2008). In the USA, the term 'the 100-mile diet' has been coined, implying that locally sourced ingredients should be sourced from producers within a 100 mile radius, whereas in the UK, locally sourced ingredients are those produced within 30 miles from the producer to the restaurant (Ilbery & Maye, 2006). The potential benefits of locally sourced ingredients are many. In line with the definition of sustainability adopted in this study, the environmental and waste reduction benefits were considered. The literature indicates that locally sourced ingredients are a potential solution to reduced food miles, which is linked to carbon accounting (Lehtinen, 2012). Short food supply chains imply that the transportation distance is reduced, resulting in minimal usage of energy and therefore, a reduced carbon footprint (Pearson *et al*., 2011). According to Weber and Matthews (2008), purchasing local food can potentially reduce greenhouse gas (GHG) emissions by approximately five percent. However, some researchers suggested that some locally produced foods have a higher carbon footprint due to transportation logistics, such as frequent deliveries and the mode of transport used (Frash, DiPietro & Smith, 2015; Pearson *et al*., 2011; Weber & Matthews, 2008). Additionally, some local foods may not be sustainably produced therefore, it is important to pay attention to other aspects throughout the entire life cycle of food production while assessing sustainability, for example, the application of fertilisers and crop watering systems (Brunori, Galli, Barjolle, Van Broekhuizen, Colombo, Giampietro & De Roest, 2016; Frash *et al*., 2015).

Another benefit from an environmental standpoint, is that locally sourced food requires less additional packaging to protect and keep the produce fresh compared to food sourced from a long distance (Pearson *et al*., 2011). From a waste management perspective, locally sourced ingredients are likely to be fresher and stay fresh longer as a result of the reduction in time associated with transportation (Frash *et al*., 2015; Pearson *et al*., 2011). This can possibly have an influence on the time it takes for the food product to spoil and consequent food wastage.

- *Utilisation of food in season*

Seasonality is referred to as '…the production and consumption of food in the natural growing or production season within the same climatic zone, that is, the food is grown or produced in their natural season without the use of additional energy, heated glasshouses, additional pesticides, thereby not creating additional greenhouse gas emissions (Macdiarmid, 2013:2). Feagan, Morris and Krug (2004) suggested that seasonal foods are of a better quality, and are fresher and tastier than those produced out of season. This may have implications on food waste generation.

- *Utilisation and consumption of organic foods*

Organic foods can be described as foodstuffs that have been produced through an ecological production management system that maximises the stability and homeostasis of the agro-ecosystems (Basona & Gebresenbet, 2018; Winter & Davis, 2006). The production is based on the use of natural resources, which are internal to the system and restricted to the use of off-farm inputs (Winter & Davis, 2006). Organic foods are produced without the use of chemical fertilisers, synthetic pesticides, growth regulators, antibiotics, and a total prohibition of the utilisation of genetically modified organisms (Basona & Gebresenbet, 2018; Niggli, 2014; Seyfang, 2006; Truong, Yap & Ineson, 2012). From the literature (Chen, 2009; Niggli, 2014), there are clear indications that organic foods are produced in the most ecologically sound method compared to conventional foods. In particular, organic foods are produced in a manner that increases biodiversity, maintains the fertility of the land, reduces pollution and releases fewer greenhouse gas emissions (Chen, 2009; Truong *et al*., 2012).

According to Benbrook, Zhao, Yáñez, Davies and Andrews (2008), Niggli (2014), Shepherd, Magnusson and Sjödén (2005) and Truong *et al*. (2012), organic food products are premium quality and have higher nutritional value than conventional alternatives, which leads to continual growth in demand from consumers. This increased demand may seemingly lead to reduced food waste generation. Another element of organic foods, which may have a bearing on food waste generation, is perceived safety. Hughner, McDonagh, Prothero, Shultz and Stanton (2007) argued that organically produced foods are safer than those conventionally produced. For example, the risk of contamination with detectable pesticide residues, is lower in organically produced foodstuffs than conventional produce. Therefore, having a diet of organic produce, reduces human exposure to pesticides (Forman & Silverstein, 2012; Smith-Spangler, Brandeau, Hunter, Bavinger, Pearson, Eschbach & Olkin, 2012). On the other hand, Winter and Davis (2006) indicated that organically produced foods possess higher rates of bacterial contamination than those produced conventionally, due to the use of animal manure, which may not have been properly composted.

Hughner *et al*. (2007) argued that blemishes or imperfections of organic produce may deter consumers from purchasing these, which may lead to food waste generation at producer or retail level. From the perspective of a food service operation, it may be assumed that if the procurement department rejects organic produce on the basis of cosmetic defects, it can lead to food waste generation for the agricultural producer or supplier.

- *Animal welfare approved food products*

A sustainable food system would be one that enhances the welfare of animals. Sustainable food service operations procure and utilise animal welfare-approved products. Animal welfare is defined as the natural rearing of animals with their non-confinement or using the free-cage system and humane slaughtering (Grandin, 2014; Harper & Makatouni, 2002). Animal welfare-approved food products are those that have been produced from animals that met the minimum standards that ensures animals do not endure avoidable pain or suffering during the production process, transportation and slaughtering (Akaichi & Revoredo-Giha, 2016). There is an increase in consumer concerns about animal welfare, which may impact food choices (Horgan & Gavinelli, 2006; Reisch, Eberle & Lorek, 2013). Studies further showed that consumers associate animal welfare with improved quality, safety and taste (Akaichi & Revoredo-Giha, 2016; Harper & Henson, 2001). Consumer food choices and perceptions about animal welfare-approved products may have far reaching implications on consumption of animal-based products, such as meat, eggs and dairy products, and ultimately on food waste generation at food service operation level (Blokhuis *et al*., 2003).

- *More plant-based dishes and less animal-based dishes on the menu*

The link between a menu and environmental sustainability is central to this study. A sustainable menu is the one that has a low environmental impact, reduces pollution, greenhouse gas emissions and species loss (Macdiarmid, Kyle, Horgan, Loe, Fyfe, Johnstone & McNeill, 2012; Sabaté & Soret, 2014). Plant-based food items are viewed as being sustainable compared to meat and dairy products (Beverland, 2014). Beverland (2014) and Macdiarmid *et al*. (2012) indicated that meat and dairy products have the greatest environmental impact. Animal products, both meat and dairy, account for 18 to 50%

greenhouse gas emissions. They substantially pollute ground water, lead to land degradation, deforestation, species loss and generally require more resources to produce (Alsaffar, 2016; Macdiarmid *et al*., 2012). On the other hand, food production of plant-based sources requires less land, uses less water and decreases land degradation compared to the production of animal sources (Beveland, 2014; Tilman & Clark, 2014). There is no study that links a sustainable menu, which has more plant-based dishes and less animal-based dishes, with food waste generation.

- *Reduction of processed foods*

Almost all food items used in food service operations are processed to some extent; minimally processed, highly processed and ultra-processed. Processed foods are products, which are converted from raw agricultural materials into products purchased by retailers (Heller & Keoleian, 2003). Processing foods, their packaging and transportation is energy intensive. According to Heller and Keoleian (2003), the amount of energy used for processing food, accounts for 16% of the total energy used by the entire food system. Additional energy is used when the food items are transformed into a meal at the food service operation. Despite the extent to which processing foods is unsustainable, it preserves the quality and functionality of food (Lazarides, 2011). Dávila-Aviña, Solís-Soto, Rojas-Verde & Salas (2015) contend that processed foods lead to the production of safer foods, enhance their sensory attributes and are more convenient to cook. It is further noted that processed foods are packaged using innovative technologies, such as modified atmosphere packaging or a reduced oxygen-controlled atmosphere, which protects food from microorganisms and other foreign objects, therefore extends their shelf life (Dávila-Aviña *et al*., 2015; Sellhewa & Martindale, 2010). These aspects have possible implications on the extent of food waste generated at the food service operation level.

3.6 CONCEPTUAL FRAMEWORK OF THE STUDY

Based on the literature reviewed and the theoretical perspectives discussed in the previous chapter, the conceptual framework in Figure 3.15 (next page) was developed. The framework was further developed throughout the study.

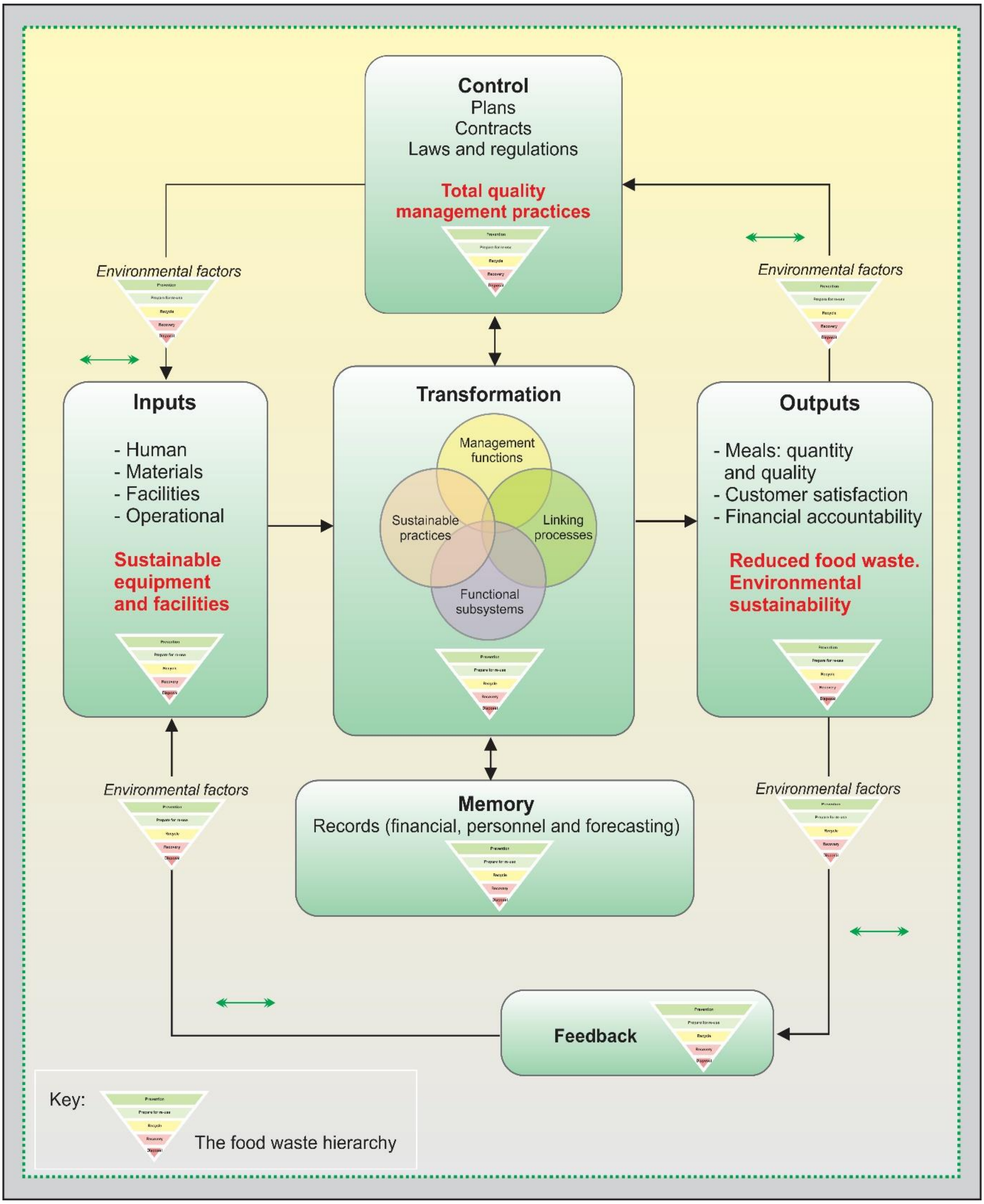


FIGURE 3.15: CONCEPTUAL FRAMEWORK OF THE STUDY

The conceptual framework starts with the inputs, which have an influence on food waste generation or its prevention. The study integrated sustainable inputs (equipment and facilities) with a view to them having the potential to prevent food waste in the food service system. These inputs are transformed into outputs through the activities and processes in the transformation subsystem. These include the management functions, and functional and linking processes, which are considered instrumental in preventing food waste or causing it. Sustainable practices were integrated into the transformation subsystem to adopt those that prevent waste and additionally reduce environmental harm. The model further indicates the outputs that are important in any food service operation including; desired quantity and quality of food, customer satisfaction, employee satisfaction and financial accountability (Gregoire, 2013:6). These outputs are directly related to food waste. Reduced food waste and environmental sustainability are important outputs introduced and integrated in this model. The control subsystem, which comprises of plans, contracts, laws and regulations, plays a role in different ways in food waste generation and its prevention. Additionally, the model considered the influence of total quality management practices that prevent food waste. The contribution of other subsystems, such as memory, feedback and environmental factors was considered in so far as food waste generation or its prevention. At each subsystem, consideration was given to practices that promote the prevention of food waste over other options in the food waste hierarchy, as this is the most environmentally friendly alternative.

3.7 SUMMARY

In this chapter, the concept of food waste was discussed, and the definition adopted for the study. The current status of the magnitude of food waste at different levels was reviewed to give a picture of the extent of the problem. Causes and drivers of food waste in the context of food service systems were analysed to guide the development of effective food waste prevention strategies. The literature review was further discussed concerning the importance of food waste prevention from the economic, social and environmental perspective. In addition, the total quality management practices and their influence on food waste generation in the food service system, were discussed. The review further covered sustainability practices in food service operations and their potential contribution to food waste reduction or generation. The chapter concludes with a conceptual framework developed from the aspects considered.

Chapter 4: RESEARCH METHODOLOGY

PHASE 3: VALIDATION PHASE METHODOLOGY

Chapter 4

RESEARCH METHODOLOGY

The research methodology, which was a multiphase mixed methods design, is discussed in depth in this chapter.

4.1 INTRODUCTION

The primary goal of this study was to develop and validate a total quality management tool integrating sustainability practices, which could be applied to address food waste in university residential food service units as stated in the first chapter (Section 1.5.1, page 10). In this chapter, the research design and methodology used to address the already mentioned research aim and objectives (Section 1.5.1, page 10), is discussed. This chapter includes a discussion to justify the selection of the participants, data collection, data analysis, reliability and validity of the study. An overview of the ethical considerations is also covered.

4.2 PHILOSOPHICAL WORLDVIEW

The study followed a pragmatic philosophical assumption with a combined qualitative/ quantitative (mixed methods) approach. Pragmatism is a philosophical tradition that originated in the United States during the latter decades of the 19th century (Maxcy, 2003:52). The most important of the 'classical pragmatists' are Charles Sanders Peirce (1839–1914), William James (1842–1910) and John Dewey (1859–1952) (Goldkuhl, 2012; Lewis, 1976). More recent writers, who have discussed this perspective, include Murphy, Patton and Rorty (Creswell, 2014:10). According to Cherryholmes (1992), Creswell and Plano Clark (2011:44), Goldkuhl (2012) and Morgan (2014), pragmatism requires a research idea, which is problem-solving oriented, to yield practical consequences. The assumptions of this paradigm are in line with the purpose of the study; developing a total quality management tool that integrated sustainability practices that could address the food waste problem in university food service units.

The pragmatist epistemology had relevance to this study as opposed to the positivist and anti-positivist views of scientific discovery. Positivists hold a deterministic philosophy in which causes determine outcomes. Anti-positivists hold the perspective that the generation of meanings is based on the interpretations that social actions have for the people being studied (Bryman, 2013:2; Creswell, 2014:6). Pragmatism, on the other hand, opposes positivism on the basis that no theory can satisfy its demands – objectivity and falsify-ability, and rejects anti-positivism on the grounds that effectively any theory will satisfy them (Pansiri, 2006). As such, pragmatism sidesteps issues of truth and reality, and reorients the assessment of theories on the basis of their capacity to solve practical problems (Feilzer, 2010). This was the cornerstone of the study; to use theory to solve the problem of food waste in food service operations.

Pragmatism has been hailed as the foundation of mixed methods; inquirers have the choice to integrate both quantitative and qualitative research strategies in a way that meets the purpose of the study (Johnson & Onwuegbuzie, 2004). In line with this, Feilzer (2010) added that a mixed methods research approach does not fall comfortably with either the positivism or the anti-positivism paradigm. Given the aforementioned, the pragmatism worldview was appropriate for this study.

4.3 RESEARCH DESIGN – MULTIPHASE MIXED METHODS

For this study, a multiphase mixed methods design, which featured some elements of both exploratory and explanatory designs, was adopted (Creswell, 2014:14). A three-phase tool development process, as shown in Figure 4.1, was followed. The three phases were: the predevelopment phase, developmental phase and validation phase (De Vos, Strydom, Fouché & Delport, 2011:215-219). Prior to the main investigation, a preliminary study was conducted to identify the problem, which was the generation of food waste within the university residential food service system. During the predevelopment phase, an in-depth systematic literature review was conducted to explore the commonly cited primary dimensions of total quality management and sustainability practices. Specific sub dimensions and indicators under each of the primary dimensions were further explored. In the development phase, the causes of food waste were explored. Qualitative methods were used to gain an in-depth understanding of the problem of food waste, and to develop a tool that would adequately address the problem. The primary goal of the research was to develop a total quality management tool, integrating sustainability practices to address food waste in the university food service system. An exploratory study was undertaken to further explore dimensions and indicators of TQM and sustainability practices relevant to the specific context of the university food service operation.

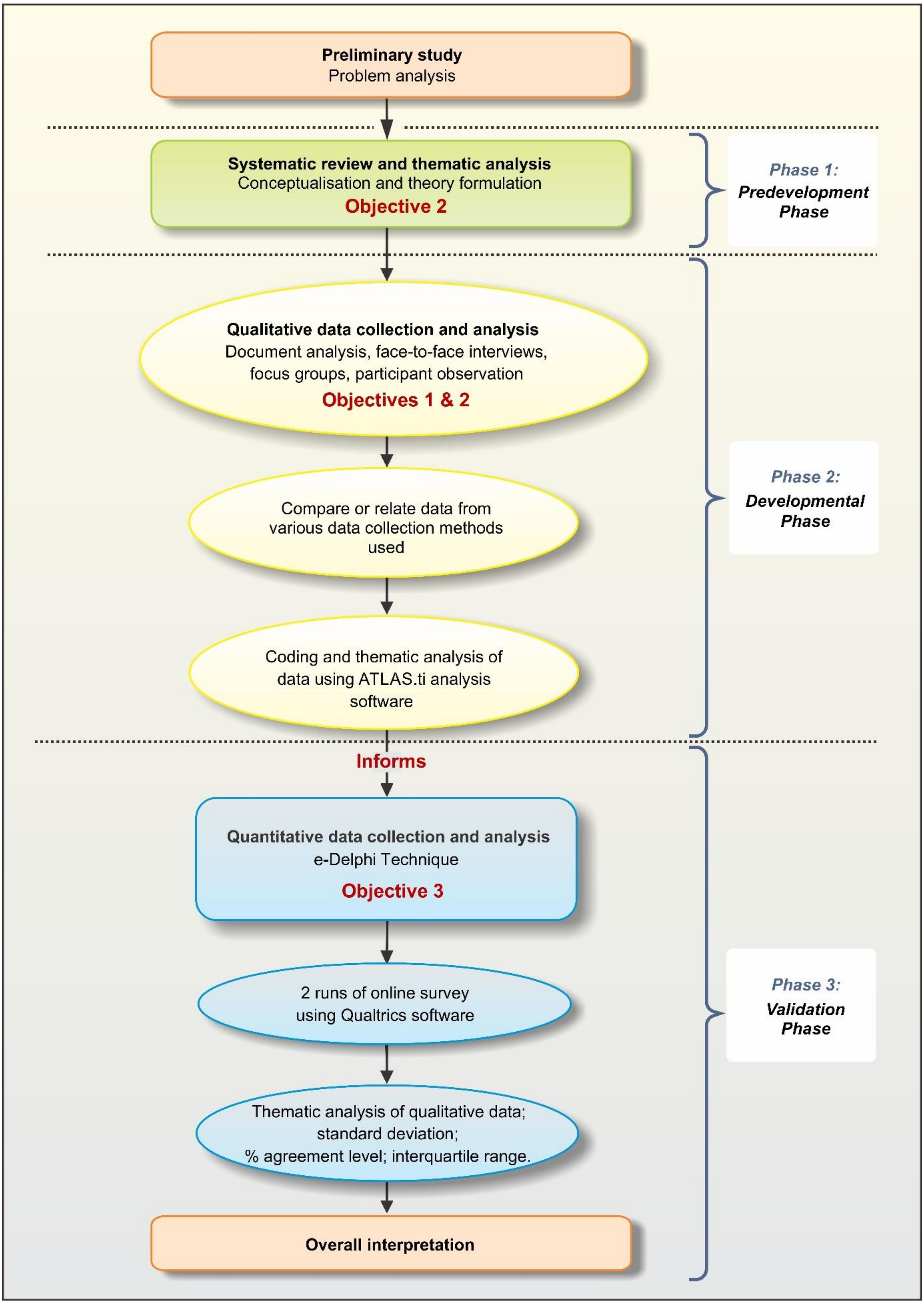


FIGURE 4.1: THE MULTIPHASE MIXED METHODS DESIGN APPLIED

After the development of the tool from the qualitative findings, the study moved into its third phase (validation), which was predominantly quantitative, with the qualitative strand embedded. To address the issue of food waste, the e-Delphi technique was introduced in this phase to establish the importance of the dimensions that were identified and to validate the total quality management tool, while integrating sustainability practices.

4.4 PRELIMINARY STUDY

A preliminary study was conducted from May to June 2015, prior to data collection for the main study. The aim of the preliminary study was to identify the most prevalent problems affecting the university food service establishments. Participant observation and document analysis were conducted during this stage. The results were needed to decide on the most prevalent problem to be addressed with this research. The preliminary study was important to assist the researcher to decide on the methodology appropriate for the main study.

Four food service units at the University of Pretoria participated in the preliminary study. The findings suggested that food waste was the most prevalent problem in the University residential food service units. Records from the Purchasing Contracts and Stock Control Division of the University indicated that the total cost of food waste across the residential food service units was estimated at R290 650,18 per annum (approximately $20,000); equivalent to approximately 6.03% of the annual food purchases budget (Van der Westhuizen, 2015). The preliminary investigations further suggested that the lack of a holistic quality management system appears to contribute to food waste. The researcher, therefore found there was a need to develop a total quality management tool that integrated sustainability practices to address food waste within the University food service system.

PHASE 1: PREDEVELOPMENT PHASE

The main study began with a predevelopment phase. This was to conceptualise and explore dimensions and indicators of total quality management and sustainability practices, with a potential to address food waste in food service units. A systematic literature review was undertaken. This is explained in the following section.

4.5 SYSTEMATIC REVIEW METHODOLOGY

The first activity conducted prior to the development of the tool to address food waste, was an in-depth, systematic review of the literature on total quality management and sustainability practices. These key constructs, their dimensions and indicators informed the preliminary development of the tool to address food waste. Ford, Berrang-Ford and Paterson (2011) defined a systematic review as a methodological procedure that involves the mapping and assessment of the literature on a given topic or research objective, structured to rigorously evaluate and summarise the existing understanding. The systematic review process was conducted in six consecutive phases as outlined in the following section and illustrated in Figure 4.2 (next page).

4.5.1 Identification of research objectives addressed by the review

The systematic review was conducted to address the following primary objective and sub-objectives:

Primary objective 2:

To develop a total quality management tool integrating sustainability practices, which can be used to address food waste in the university food service system.

Sub-objective 2.1:

To investigate total quality management practices that contribute to the prevention of food waste in the University food service units.

Sub-objective 2.2:

To explore sustainability practices that the University food service units can implement to address food waste.

4.5.2 Search process

According to Caldera, Desha and Dawes (2017), an important step of the systematic review is describing the search process as it ensures transparency. In line with this, this section describes how the search process was conducted. As suggested by Jesson, Matheson and Lacey (2011:27-28), the first step was to identify a search strategy. This involved selecting a combination of search terms and Boolean operators to search for relevant sources (Table 4.1). Further to that, a selection of relevant electronic databases was made; these included Science Direct (Elsevier), Taylor & Francis, SAGE, Emerald Insight, Wiley Online Library, EBSCOhost

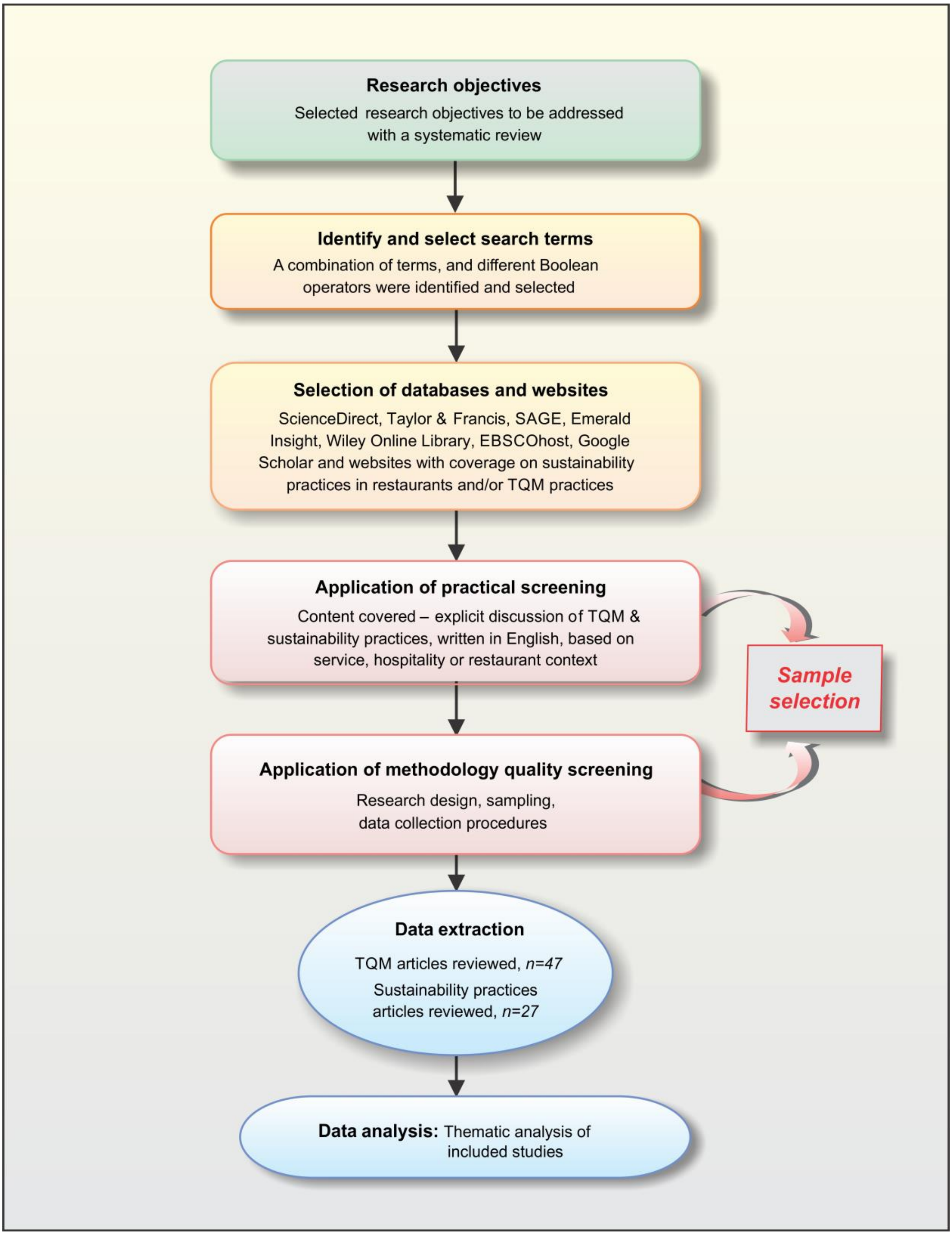


FIGURE 4.2: STEPS FOLLOWED IN CONDUCTING THE SYSTEMATIC REVIEW

and Google Scholar. The engagement of a wide scope of databases was important to ensure that relevant information from the business, management and science perspectives was captured thus ascertaining validity (Caldera *et al*., 2017). Academically refereed, full-text journals on total quality management were sought using search terms as shown in Table 4.1.

TABLE 4.1: SEARCH TERMS AND BOOLEAN OPERATORS APPLIED WHEN SEARCHING FOR RELEVANT LITERATURE

Constructs	Search terms and Boolean operators applied
Total Quality Management (TQM) practices	• Total quality management • Total quality management practices • Total quality management in food service • Total quality management AND food service (or AND restaurants, or AND catering) • Total quality management practices AND food service (or AND restaurants, or AND catering).
Sustainability practices	• Sustainability practices • Environmental sustainability practices in restaurants (or food service operations or catering) • Environmentally friendly practices in restaurants (or food service operations or catering) • Sustainability practices AND food service (or AND restaurants, or AND catering) • Green practices in restaurants OR food service operations OR catering • Green management practices in restaurants OR food service operations OR catering.

4.5.3 Inclusion and exclusion criteria

Following the in-depth search of the literature, articles related to total quality management, as well as sustainability practices in food service operations or restaurants were retained for practical screening (Lefadola, Viljoen & Du Rand, 2018). Inclusion and exclusion criteria (Table 4.2) were developed and applied to screen the retained articles. In line with the recommendations by Nicolay, Purkayastha, Greenhalgh, Benn, Chaturvedi, Phillips and Darzi (2012:326), the eligibility criteria were decided independently by two reviewers. The disagreements between reviewers were resolved by consensus.

TABLE 4.2: INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria	Exclusion criteria
Published from 1990 to 2018.	Published before 1990.
Original publication in English.	Written in languages other than English.
Studies on sustainability practices focusing on the service sector, or hospitality sector or food service operations.	Irrelevant scope of coverage such as those that focussed on manufacturing companies, construction companies, and automotive sector.
Studies that identify and describe TQM practices and sustainability practices.	Studies that investigated and failed to specify and describe TQM practices and sustainability practices.

4.5.4 Quality assessment

Each article meeting the inclusion and exclusion criteria was further assessed for quality, considering the rigour of the research design, sampling and data collection procedures. To fulfil the quality dimension of the assessment, the authors should have explicitly described the methodology approach and shown that validity had been ensured.

4.5.5 Data extraction

Data was extracted from 47 articles focussing on total quality management, and 27 articles focussing on sustainability practices. To extract data, a matrix was developed to record a summary of the characteristics of each article. This included; capturing, period of study, country, topic, purpose of the study, study design, and the study site setting. Further to that, to extract data the selected articles were imported from Endnote to ATLAS.ti software for analysis in the next stage.

4.5.6 Data analysis

Thematic analysis was applied to identify prominent themes that described total quality management and sustainability practices in the context of food service. As mentioned above, ATLAS.ti software was used to analyse the data. The thematic analysis applied in the study was an approach suggested by Braun and Clarke (2012), as illustrated in Figure 4.3, and discussed in Section 4.9.

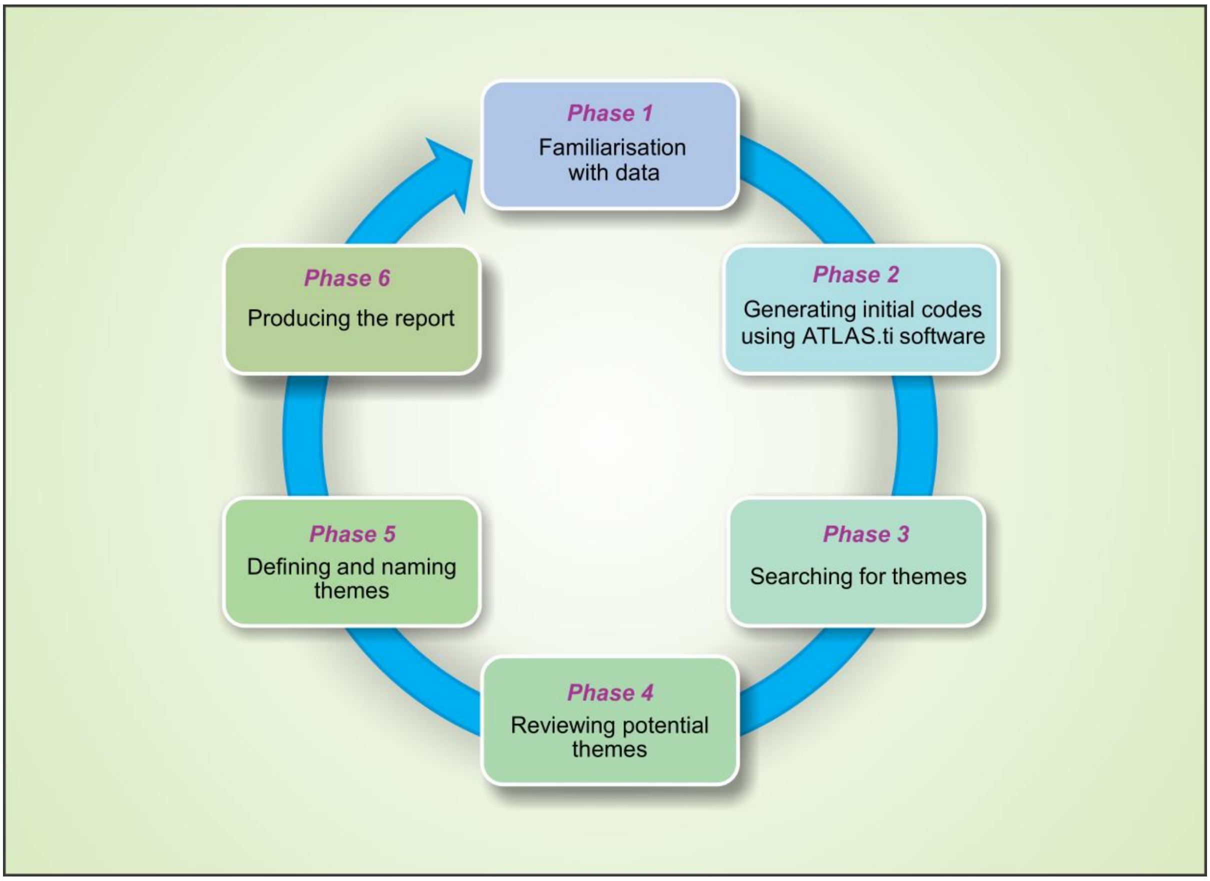


FIGURE 4.3: APPROACH FOLLOWED IN THEMATIC DATA ANALYSIS (Adopted from Braun and Clarke, 2012:60-69)

4.6 CONCEPTUALISATION AND OPERATIONALISATION FOR PHASE 1

This section describes the conceptualisation and operationalisation of the first phase of the study. Conceptualisation can be described as the process of specifying the meaning of concepts and variables to be studied (Babbie, 2016:114). The important concepts of the study have been thoroughly discussed in Chapters 2 and 3. The main concepts guiding the study are indicated in the operationalisation table (Table 4.3). According to Babbie (2016:46) and O'Leary (2014:208), operationalisation is one step beyond conceptualisation and refers to the process of turning abstract concepts into measurable variables. Operationalisation in this phase, involved developing indicators of the main concepts to be investigated, that is, total quality management and sustainability practices. The indicators were identified from the literature. Table 4.3 (next page) outlines the conceptualisation and operationalisation for Phase 1.

TABLE 4.3: CONCEPTUALISATION AND OPERATIONALISATION OF THE PREDEVELOPMENT PHASE

Primary objective 2: To develop a total quality management tool, integrating sustainability practices, which can be used to address food waste in university food service units.					
Sub-objective	**Concept**	**Dimensions**	**Indicators**	**Measuring instrument**	**Data analysis**
2.1 To investigate total quality management practices that contribute to the prevention of food waste in university food service units.	Total quality management practices.	- Quality practices of top management; - Employee knowledge and education; - Employee management and involvement; - Information and analysis; - Supplier quality management; - Process quality management; - Customer focus; - Process and product quality design.	*Tabulated in Table 4.4 below.*	Review matrix Addendum O.	Thematic analysis.
2.2 To explore sustainability practices that university food service units can implement to address food waste.	Sustainability practices.	- Sustainable food practices; and - Environmental sustainability.	*Tabulated in Table 4.4 below.*	Review matrix Addendum P.	Thematic analysis.

continues ...

TABLE 4.4: INDICATORS OF DIMENSIONS OF TOTAL QUALITY MANAGEMENT AND SUSTAINABILITY PRACTICES

Concept	Dimensions	Indicators
Total quality management practices.	Quality practices of top management.	Management actively participates in quality management efforts. Management holds regular meetings to discuss quality related issues. Management supports quality improvement efforts by providing the necessary resources. The quality policy is taken into consideration in strategic planning. Quality data are taken into consideration in decision making. The quality policy is communicated throughout the company. Top management gives employees the authority to manage quality problems. Management sets quality strategies for employees. Quality results are evaluated to check improvements. Management gives priority to production processes.
	Employee knowledge and education.	Educational programmes are evaluated. Employees are trained in subjects with regard to their speciality and daily work. Employees have knowledge and know how. Employees are educated in quality management techniques. Resources are provided for staff training.
	Employee management and involvement.	Employees, who improve quality, are rewarded. Employees are evaluated. Employees participate in quality improvement activities e.g. decision making, setting quality objectives. Employees take initiatives. Employees recognise superior quality performance. Employees are motivated to improve their performance.
	Information and analysis.	A variety of data collection methods are used to ensure reliability of quality performance data. There is adequate storage for archiving of information. Easy retrieval of stored information Systematic analysis of data.
	Supplier quality management.	There is a solid partnership with suppliers. The specifications are clearly determined by the organisation provided to suppliers. Quality audits are implemented by the organisation’s representatives at the suppliers’ site. Suppliers selected on quality rather than price or schedule.

continues …

Concept	Dimensions	Indicators
Total quality management practices. *(continued)*	Process quality management.	Process non-conformities are detected through internal audits. Critical processes are determined and evaluated. Determination of areas, processes and points for improvement. Specific organisational structures have been formulated to support quality improvement. All employees are provided with instructions. Mistakes are precluded in the process design. Setting ranges within which non-conformities are allowed.
	Customer focus.	There is a documented process of collecting customer feedback. Customers are encouraged to submit complaints and proposals for quality improvement. Customer complaints and proposals for quality improvement are selected. The organisation's managers and employees are in close contact with the customers. Customers' needs, requirements and desires are recorded and analysed.
	Process and product quality design.	Context specific information in the literature is limited thus indicators of this dimension were explored through qualitative data collection.
Sustainability practices.	Sustainable food practices.	Use of locally sourced ingredients. Seasonal food. Organic food. Animal welfare approved products. More plant-based menu items, less animal-based items. Reduction of processed food.
	Environmental sustainability.	Reduced food miles. Energy conservation. Energy efficient equipment and appliances. Heating, ventilation and air conditioning. Water efficiency.

PHASE 2: DEVELOPMENTAL PHASE

The developmental phase aimed at further refining the preliminary tool, which was developed in the first phase specific to the context of food service units. A qualitative case study approach was applied to gain a deeper understanding of the dimensions and indicators of total quality management and sustainability practices that can potentially address food waste in the specific context of food service organisations. In this phase, the understanding and identification of the causes of food waste was basic to the development of strategies to address this problem. This informed the development of the tool to address food waste. The following sections include discussions of the study area, how the participants were recruited, data collection procedures, data analysis and interpretation, conceptualisation and operationalisation, ethical considerations and how the quality of the data was ensured.

4.7 STUDY AREA

The following section discusses and justifies the case selected for the study. Further to that, the section includes how the study area was accessed, by applying a three-stage access model.

4.7.1 Study area selection

Data was collected from July to November 2016 at the residential food service unit of the University of Pretoria in Pretoria, South Africa. As discussed in Chapter 1, the University of Pretoria's residence system comprises 26 residence halls, each located around 13 residential food service units. The largest residential food service unit of the University of Pretoria – Tuks Monate was selected as the study site for this research. This residential food service unit alone, services a population of approximately 900 students residing at six of the residence halls. It is also a central production kitchen, that is, it produces and distributes meals to four satellite residential food service units. Given the magnitude of the food service unit, permission was granted for a large group of food service personnel to be interviewed and a focus group to be held. The study area was described in detail in Chapter 1, Section 1.6.

4.7.2 Accessing the study area

De Vos *et al.* (2011:325) emphasised that a successful execution of the design and data collection process is to a large extent determined by the accessibility of the setting and the researcher's ability to establish and maintain relationships and agreements with the gatekeepers and participants. Taking this into account, the researcher applied a three-stage model (Figure 4.4) adapted from Johl and Renganathan's (2009) access model, to gain access to the study site. This model closely relates to Buchanan *et al*.'s (1988) four stage access model, which is often referred to in the methodology literature.

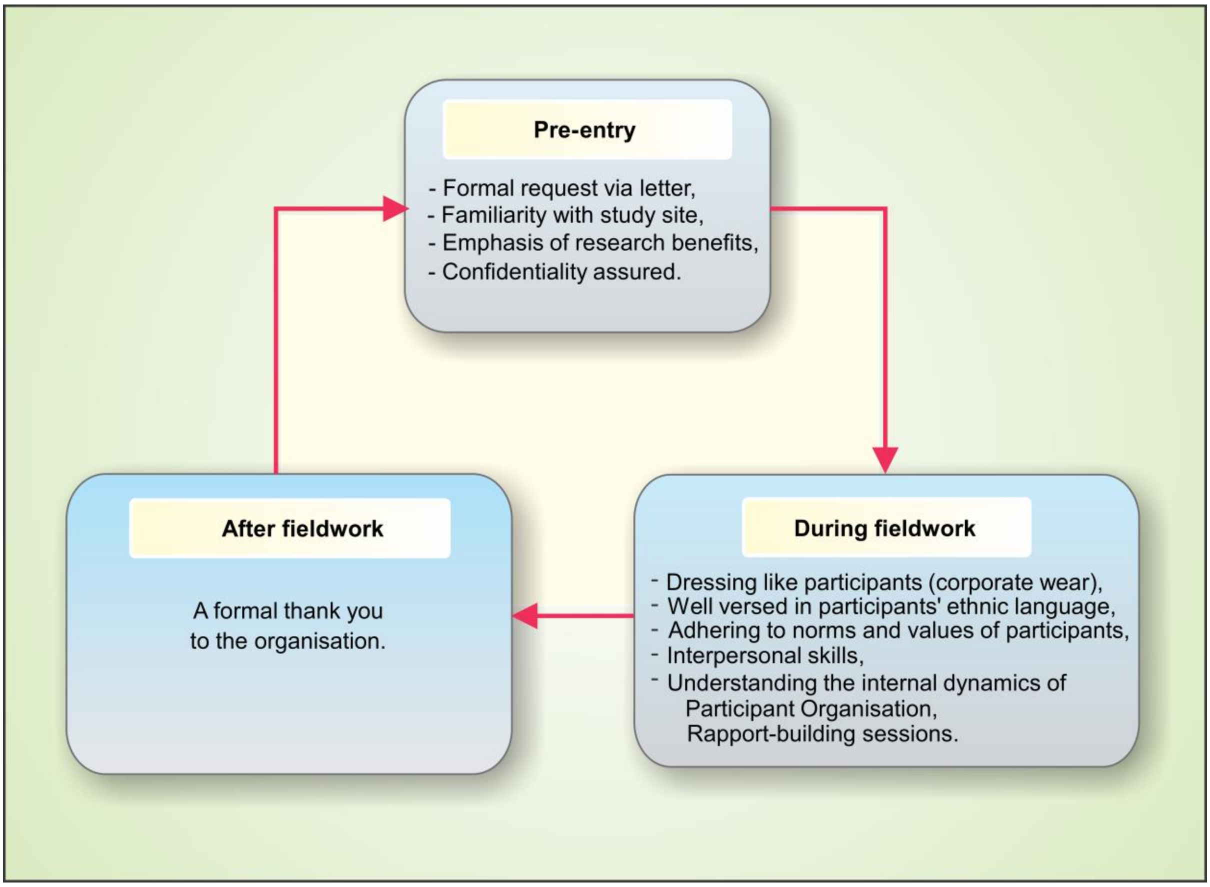


FIGURE 4.4: **THREE STAGE ACCESS MODEL** (Adapted from Johl & Renganathan, 2009)

4.7.2.1 Pre-entry to the field

A formal letter was written to the Director of Food Services, who is in charge of the University residential food service units, to ask permission for access to the study site. The letter included an introductory statement informing the Director about the aim and objectives of the study (Addendum A). Additionally, the researcher, being a student at the University, used personal access and individual rapport to gain access to the familiar study site (Johl & Renganathan, 2009). To obtain the acceptance and trust of the participants, the researcher assured them of confidentiality and anonymity of their information before data collection began. In addition to that, the researcher emphasised the benefits of the study to both managers and food service workers as research participants.

4.7.2.2 During fieldwork

During the initial contact with the participants, the Food Service Unit manager of the study area was used as a gatekeeper. The Food Service Unit manager held a meeting to introduce the researcher to the participants. During the field work, the researcher dressed in similar corporate wear to that of the participants, which was considered important to gain their trust and confidence. Additionally, this was purposely done to encourage the participants not to see the researcher as an outsider nor in the role of a researcher. The management was interviewed in English, which is the common language used by management, whereas food service assistants (back of house and front of house personnel) were interviewed in the ethnic language, Tswana, popularly used in the Gauteng Province. This was advantageous as it encouraged the participants to express themselves. The researcher also adhered to the organisational culture, values and procedures, as well as exhibiting good interpersonal skills.

Building a relationship with the participants and creating an environment conducive to the research investigation was not an easy task. Despite all the documentation and verbal explanation about the research project, some participants were still not comfortable with disclosing information, even after consent was given to participate. Such comments as ‘Why are you asking too many questions?’, ‘Are you a spy?’, were often jokingly said. To address this, the researcher held rapport building sessions to assure the participants that she was at their organisation to learn from their experiences and knowledge, and that information shared would be kept strictly confidential. With time, trust was gained. To avoid trust and communication barriers, the researcher used experienced and respected participants (both from the front of house and back of house) as gatekeepers. Additionally, there was a case where some participants became curious about the views of other participants. They would ask what the researcher’s experiences were and what the participants said regarding the subject being investigated. Giving answers to these types of questions was avoided as this would have contravened the terms of confidentiality and the requirement to maintain the anonymity of the participants. Another factor was the internal dynamics of the organisation, which proved to be a challenge in maintaining access. There was on-going conflict between staff members as well as power struggles between the different levels of staff. Staff members were discreet in terms of providing organisational related information. To address this, the researcher wrote several letters to management requesting access to information at different stages of data collection. The researcher had to continuously reassure the participants about the confidentiality of their shared information.

4.7.2.3 After fieldwork

Following the data collection, a formal thank you letter was emailed to the study-case organisation. The participants were gathered at the study site to formally thank them for their participation. This was done to maintain a good rapport and to ensure that in the event of missing information, it would be easy to approach them for additional material.

4.8 DATA COLLECTION PROCESS

Data collection in the second phase involved an integration of four different data collection methods; document analysis, face-to-face interviews, focus group discussions, and participant observation. The following section discusses in detail how the data collection was executed, using these different methods.

4.8.1 Document analysis

Bowen (2009) described document analysis as a systematic procedure that involves reviewing or evaluating documents to gain an understanding and develop empirical knowledge. Document analysis for this study involved exploration and analysis of existing records at the organisation, included weekly, and financial reports of food waste (the amount, cost and causes) generated by the food service unit. The researcher spent four (4) to six (6) hours per day at the University residential food service unit analysing these documents for a period of two (2) weeks. However, the process of referring to documents continued throughout the entire period of the field work. These were used to corroborate data collected via other methods.

The document analysis approach used in the study, is discussed in the following section. The researcher followed the guidelines of Bowen (2009) and De Vos *et al.* (2011:381) to integrate the document analysis. The process of document analysis encompassed; purpose identification, document search, data evaluation, data extraction and data analysis.

4.8.1.1 Purpose identification

The initial stage involved a clear identification of the purpose that the document analysis had to address. Whittemore and Knafl (2005) argued that this was an important stage that facilitates all other stages of the analysis, particularly the ability to differentiate between pertinent and extraneous information in the data extraction stage. The aim of the document analysis was to investigate the causes of food waste in the University residential food service unit. Various tools, including those related to quality, which are used for standard operating procedures, were analysed to explore quality management-based practices and indicators in the context of food service units.

4.8.1.2 Document search

The researcher performed a search and identification of relevant documents that addressed the objectives of the study. The Food Service Manager at the research site was asked for existing records that related to food waste. Copies of the relevant documents were obtained for data evaluation and analysis.

4.8.1.3 Data evaluation

Records identified with coverage on the causes of food waste generation, quality management and sustainability related practices were retained for further evaluation. A framework for inclusion and exclusion was developed and applied to screen the retained records (Table 4.5). Reviewers helped in reviewing the inclusion and exclusion criteria in order to ensure quality of the data.

TABLE 4.5: INCLUSION AND EXCLUSION CRITERIA FOR DOCUMENT ANALYSIS

Inclusion Criteria	Exclusion Criteria
1. Documents written in English. 2. Reports from January to November 2016. 3. Documents with a balanced view of issues. 4. Coverage on food waste generation within the case food service unit as well as quality management practices.	1. Written in languages other than English. 2. Reports published before January 2016. 3. Documents incomplete, selective and only with positive aspects. 4. Records that did not cover any food waste generation issues nor quality management practices at the food service unit.

After the application of the inclusion and exclusion criteria, a set of documents tabulated in Table 4.6 were sampled for analysis.

4.8.1.4 Data extraction and analysis

The researcher critically read and scrutinised documents. A document analysis guide (Addendum B) was used to record data and divided it into sub-categories. Data indicating causes of food waste at each point of the food service system, as well as indicators of quality management and sustainability were extracted. ATLAS.ti software was used to record the data extracted from the documents. Thematic analysis was used to analyse the data.

TABLE 4.6: SET OF DOCUMENTS SAMPLED FOR ANALYSIS

Document type	Description
Food waste records	• Records of damaged food items from the suppliers. • Daily production and serving log sheets. • Monday report. • RCL waste record sheets, which track and report on movement of food, and records food waste generated by the food service operation, were considered.
Financial records	Monthly financial reports as well as: • Waste report. • Z-report (waste calculation). • Production waste.
Procurement records	• Suppliers' evaluation reports. • Food specifications.
Receiving records	• Food inspection (upon receiving) reports.
Storage, inventory and issuing records	• Stock movement records. • Stock issuance records. • Records of stored (prepared, chilled/ frozen) products.
Preparation and production records	• Recipes. • Production plans. • Product evaluation report. • Yield records.
Distribution records	• Food delivery reports, including those of complaints and rejections from remote kitchens.
Service records	• Food evaluation records. • Meal statistics. • Records of meals booked and collected and booked meals but not collected. • Records of leftover food.
General	• Overall food service unit inspection tools and reports.

4.8.2 Face-to-face interviews

The second activity was the semi-structured face-to-face interviews. A total of five interviews were conducted, one with each of the five members of management, at the study site. Qualitative face-to-face interviews were particularly suitable for this study as these enabled the researcher to obtain detailed information from the interviewees. This covered an account of historical information that could not have been easily observed or gathered through alternative methods, given the short duration of the study (Creswell, 2014:191; Stephens, 2007). The participants provided detailed insights about the study topic based on their extensive experience as employees at the University's residential food service units. The flexibility of this approach allowed for collecting information that was not previously thought of as pertinent by the research team but added value to the research area (Gill, Stewart, Treasure & Chadwick, 2008). This approach was useful in that it enabled the researcher to clarify any questions to the interviewees, especially concerning the construct of sustainable practices. The researcher could also seek clarification and elaboration on aspects that were not clear (Stephens, 2007). Conducting face-to-face interviews was advantageous as a 100% response rate was achieved. The following section gives a detailed account of how the face-to-face interviews were conducted.

4.8.2.1 Recruitment and selection of participants

Qualitative researchers have been criticised for not justifying the sample sizes they used in their studies (Boddy, 2016). The literature on qualitative methodology, therefore, emphasises the need to ascertain sample sizes, in a similar manner to quantitative studies, though not by the same means (Malterud, Siersma & Guassora, 2015). Considering this, the researcher's sampling procedures were guided by being appropriate and adequate (O'Reilly & Parker, 2012). The researcher applied a purposive or judgmental sampling strategy to select the participants, who would best assist the issues central to the importance of the purpose of the study (Creswell, 2014:191). The sample consisted of participants who had knowledge and experience of the phenomena to be studied.

Participants should be selected on the strength of their defining characteristics as holders of data needed for the phenomenon being investigated (Rowley, 2012). In this way, the researcher was likely to obtain the best possible information to answer the research questions (Maree, 2007:178). Taking this into account, the criteria for the selection of the participants for the qualitative face-to-face interviews were as follows:

- Managerial role at the food service unit: members of management at the food service unit were considered for face-to-face interviews. These individuals had the most insight, involvement in and relevance to quality management practices, sustainable practices and operational activities that generate or prevent food waste. The food service manager, assistant manager of purchasing and stock control, assistant manager of front of house, assistant manager of back of house, and assistant manager of transport and logistics, were selected for face-to-face interviews.

- Experience: the level of experience of working at the University's residential food service unit was an important factor in the selection of the participants, as it may have had a bearing on the depth of information. The participants were therefore, selected if they had more than two (2) years working experience at the University's residential food service unit.

As discussed above, applying the set selection criteria, five food service workers in different positions of management at the study location were selected to participate in face-to-face interviews.

4.8.2.2 Construction of the interview protocol

One important element is the construction of the interview protocol or the interview guide. A semi-structured interview format was adopted, where several key open-ended questions that defined the area to be explored, were included but allowed the interviewer or interviewee to diverge to pursue the subject of discussion in more detail (Gill *et al*., 2008). To create effective research questions, the questions were open-ended, worded clearly, and neutral (Irvine, Drew & Sainsbury, 2012; McNamara, 2009). The interview guide applied is attached as Addendum C.

4.8.2.3 Pilot testing

After the preparation of the interview protocol, it was piloted with a small number of participants at Tuks Village food service unit – one of the University's residential food service units. Turner (2013) claimed that this was an important practice that would enable the researcher to determine if there were any flaws, limitations or weaknesses within the interview guide. By piloting the interview guide, the researcher determined if any questions were poorly structured or repetitive, and if the flow of questions was inappropriate. The pilot test assisted the researcher with amendments and refinement of the questions as follows in the next section.

4.8.2.4 Amendment of the interview protocol

Following the pilot test of the interview protocol, some questions were amended. Repetitive questions were deleted. Some questions, which were asked as one question, were amended to ensure clarity and each aspect was adequately addressed. For instance, a question on quality management and sustainability practices was initially asked as one question. That resulted in the participants not addressing sustainability practices therefore, the question was separated into two separate questions. The general structure and flow of the questions were also amended. For example, some questions were structured that they only produced yes or no answers, therefore, such questions were amended to be open ended.

4.8.2.5 The interview setting

Before the actual interviews could be implemented, consideration was given to the interview setting. The researcher agreed with the interviewees on the venue, date and time of the interview and confirmed closer to the date. It was arranged by both parties that the interviews would be conducted at the interviewees' work offices as the setting was considered comfortable and easily accessible to the participants (Bolderston, 2012).

4.8.2.6 The actual interview implementation

In the following section the interview process is discussed from the point of introduction until the end of the interview.

(a) Introduction to an interview

The actual interview began with confirming the purpose and the approximate duration of the study, the reason and the general format for the interview, and the potential benefits to the organisation. The ethical issues were addressed, which included; obtaining written consent from the interviewee, discussing issues of confidentiality, anonymity and the right to withdrawal, as well as obtaining permission to take notes and audio tape the interview.

(b) The main component of the interview

This stage primarily involved asking the participants questions to address the research objectives. As suggested by Bolderston (2012) and McNamara (2009), one question at a time was asked. This ensured that the focus remained on the issues at hand, rather than other topics. This ensured that all areas of the interview were adequately discussed, and in-depth information was obtained. The interview started with relatively easy questions, then proceeded to complex ones. This allowed for the participants to be at ease, built up their confidence and rapport, and generated data that subsequently developed the interview further (Gill *et al*., 2008; Rowley, 2012; Stephens, 2007). As the participants discussed the topic being investigated, the researcher remained as neutral as possible and encouraged responses with occasional nodding, smiling, looking interested and making encouraging phrases like 'mmm, u-huh', so as to gather as much information as possible (Gill *et al*., 2008; McNamara, 2009). Other techniques that were used to encourage the interview further, included responding to remarks made by the participants and using probing comments (Bolderston, 2012). During the interview, the participants were guided to focus on the matter being investigated, especially the major topics (Turner, 2010). Taking notes was carefully done, while trying not to jump to conclusions nor showing emotions to avoid influencing the answers (McNamara, 2009).

(c) Conclusion

At the end of each interview, the researcher thanked the participants for their availability, participation and valuable contribution to the study. The major points of the interview were summarised and the participants were asked if there was anything further to add or query (Soklaridis, 2009). This gave respondents an opportunity to raise issues they had not thought of, and those that seemed important but were not dealt with in the interview (Gill *et al.*, 2008). From this the researcher discovered new, unanticipated information.

4.8.2.7 After the interview

As recommended by McNamara (2009), immediately after the interview, the researcher verified that the tape recorder had been working properly, checked notes and amended any handwriting that was not clear. All tape-recorded interviews were transcribed verbatim to prevent bias and provide a permanent record of the discussions (Gill *et al*., 2008). Field notes were made immediately after each interview to avoid any challenges that were discussed, such as remembering issues, and to make the data analysis process easier (Doody & Nooman, 2013).

4.8.3 Focus group discussions

For the third activity, the researcher conducted focus group discussions at the research site. Bryman (2012:501), De Vos *et al*. (2011:361) and Owen (2001) all defined a focus group as a systematically structured discussion designed to obtain perceptions on the topic under study from more than one, but usually, at least four interviewees. Three focus group sessions were conducted as at this point there was lack of diversity in the responses and the discussions reached saturation (De Vos *et al*. (2011:367). The focus group discussion technique was particularly selected for this study to explore multiple viewpoints or perceptions of the participants regarding issues of food waste, total quality management and sustainability practices with their experiences in the food service operation. The use of focus groups as a data collection method enabled the researcher to generate complex information at a low cost in the shortest period of time (De Vos *et al*., 2011:361). The approach which was followed to organise and implement the focus group discussions is discussed in detail in the following subsections.

4.8.3.1 Selection of participants

As suggested by Krueger and Casey (2014:4), purposive sampling was applied to identify participants for the focus group discussion. The researcher conducted a brief preliminary interview with the prospective participants, prior to finalising their selection, to ensure their suitability for inclusion. The questions that were asked focused on the role played by each participant and the extent of their engagement in the activities of the food service unit.

The following criteria were particularly important for selecting the participants for the focus group discussions:

- Individuals with the most involvement in and relevance to food related activities by holding a position within the food service operation as either the cooks, kitchen assistants, servers, store clerk or any other related role within the food service unit.
- Food service staff working at the residential food service unit of the University of Pretoria on a full-time basis. Specifically, focus was on food service workers, who worked a minimum of 40 hours per week, so that information could be obtained from them with enough exposure to the activities of the unit.
- Adequate time – the fact that some focus groups were planned to be conducted during staff breaks to minimise the impact on food service operations, meant that only the participants willing to sacrifice their lunch or tea breaks could be considered for selection to participate in the focus groups.

4.8.3.2 Designing the focus group discussion guide

De Vos *et al*. (2011:364) emphasised that careful planning of probes and questions to ensure effective focus group discussions, is crucial. The researcher carefully considered what information was wanted and which objectives would be addressed by the focus groups. A focus group guide was then developed, which was essentially an outline of the key issues, areas and questions to be covered during the focus group discussion (Tynan & Drayton, 1988). All questions were open-ended and non-committal, leaving the participants to discuss the issues without being influenced by the wording or presentation of the questions. A combination of different categories of questions was included, progressing from an opening question, introductory, transition, key and ending the questions (Breen, 2006; Wong, 2008). The researcher ensured that the wording of the questions was simple, clear, short and jargon free so that the participants could easily understand these (Krueger & Casey, 2014:7). The focus group guide was in English and translated into Tswana, the language spoken and understood by the focus group participants. Addendum D is the focus group discussion guide.

4.8.3.3 Piloting the focus group discussion guide

The focus group guide was pilot tested to ensure the approach or questioning would work. (Breen, 2006). The pilot test was conducted with four food service workers at another University residential food service unit (Tuks Village) as they exhibited similar characteristics to the participants of the main study. After the development of the focus group guide, the pilot study was conducted in July 2016. The researcher evaluated the questioning of the targeted group. After piloting the focus group guide, the researcher revised the structure of the questions; some were reworded, and some were deleted.

4.8.3.4 Group composition

The methodology literature showed that it was important to consider the composition of the focus group. Specifically, the researcher must determine the homogeneity or heterogeneity of the focus group participants (Roller & Lavrakas, 2015:107). The researcher considered homogeneity as a key principle in the focus group compilation, as it was essential for group interaction and dynamics (McLafferty, 2004). Umaña-Taylor and Bámaca (2004) stated that the more homogenous the focus group composition is, the more likely that the participants will voice their views and experiences, and the more intense the discussions may become. The participants were therefore, grouped according to their roles in the food service unit. The researcher conducted separate focus group discussions for each of the back-of-the-house and front-of-the-house workers. Staff members at management level were excluded from these focus groups to avoid power dynamics that may have inhibited the discussions (Stewart & Shamdasani, 2015:51).

4.8.3.5 Focus group discussion setting

De Vos *et al*. (2011) contend that focus groups should be held in a comfortable, non-threatening environment so as to promote conversation and communication. According to Krueger *et al*. (2001) a suitable environment is one that is familiar or neutral to focus group participants. The researcher conducted focus groups in a function hall at the food service unit where the participants worked. This location met the needs of both the researcher and the participants. For the researcher, the environment was quiet and conducive enough to hold discussions and capture data. For the participants, the discussion setting was a familiar environment and convenient.

4.8.3.6 Conducting the focus group discussions

(a) Preparation

Liamputtong (2011:72) recommended that the location and setting for the focus group discussions should be prepared in advance. The researcher visited the site before the scheduled day to confirm that it was available for use and in a good condition for conducive discussions. The table and chairs were arranged in a horseshoe to maximise participant interaction and to foster discussion (Folch-Lyon & Trost, 1981). The seating arrangement was in a secluded area that eliminated disturbances from loud noises and frequent movements. The researcher ensured that the recording equipment was available and in working order (Wong, 2008).

(b) On arrival and pre-discussion stage

On the day and time scheduled for the focus group discussions, the researcher arrived in time to welcome and greet the participants as they arrived. De Vos *et al*. (2011:371) suggested that prior to the commencement of the focus group discussion, researchers should engage in 'small talk' with the participants to create a warm, welcoming, friendly and comfortable environment to make them feel at ease. The researcher made small talk with the participants before the discussions began. The researcher assessed the characteristics of the participants, particularly to determine the extent to which participants talk so as to manage the group dynamics (Liamputtong, 2011:73).

(c) Introductory stage

Once the participants were settled, the researcher commenced the session by introducing herself as the student undertaking the study and explained that she would be learning from their knowledge, experience and perceptions. The participants were welcomed and thanked for agreeing to contribute to the focus group discussion. The participants were then invited to introduce themselves. Wong (2008) suggested that this is an essential practice that is useful in building rapport and creating a sense of group cohesion. The researcher used this pre-discussion stage to inform the participants of the nature of the study to eliminate assumptions about its purpose (De Vos *et al*., 2011: 371). It was explained that the information needed was regarding quality management, sustainability practices and food waste. The researcher reassured the participants of the value of their views, and that there were no wrong or right answers to the questions. Furthermore, it was explained to the participants that it was acceptable to disagree on issues as this would allow the researcher to explore the varying perspectives of the topic under discussion (Liamputtong, 2011:73). Ground rules and instructions were provided, keeping these as brief as possible to avoid creating an expectation that the researcher would dominate the discussion (De Vos *et al*., 2011:371). Permission to record the discussion and take notes was requested at this stage. The participants were assured of anonymity and confidentiality of the information collected from them. The researcher then obtained their written consent.

(d) Questioning stage

At this stage the researcher began asking questions relevant to the issues being investigated. The question guide, which was prepared before the focus group session, was used to guide the discussion and to tap into the attitude and perceptions of the participants regarding the investigation. However, the researcher did not entirely rely on the question guide; the participants were allowed to discuss and explore other promising issues. As suggested by Gill *et al*. (2008), prompts and probes were used to make the participants discuss and interact more. Pauses, which occurred during the discussion, were not interrupted as these prompted additional views from participants.

(e) Ending the interview stage

At the end of the focus group session, the researcher summarised the main points raised by the participants (De Vos *et al*., 2011:372). Additionally, the researcher sought verification on the views expressed and asked the participants if they had anything else to say. When there were no more questions and the participants had nothing else to ask or add, the session was ended. The researcher finished off the session by expressing gratitude for the valuable contributions made by the participants.

(f) After the session

After the session, the participants were provided with refreshments. Liamputtong (2011:73) found that offering refreshments created a relaxed atmosphere that allowed for further discussions on the topic. The researcher paid attention to issues related to the investigation that the participants continued to discuss while they had refreshments. As soon as the participants had left, the researcher carefully considered aspects that were discussed. The themes that arose during the discussion were assessed, as well as whether participants had provided adequate information and if there was anything that needed to be done differently in subsequent sessions (De Vos *et al*., 2011:372).

4.8.4 Participant observation

The fourth activity was participant observation, which Jorgensen (2015) described as a qualitative research procedure with roots in traditional ethnographic research. This investigates situations and or people in their usual work setting and everyday context through exposure to or involvement in the daily activities of the participants in the research setting. It entails the systematic, detailed observation and recording of people's behaviour, actions and interactions (Hennink, Hutter & Bailey, 2010:164). The researcher observed practices (Figure 4.5) related to food waste generation, food waste prevention, quality management and sustainability. The observations were made over a period of 16 days since the University food service unit followed a 16-day cycle menu, during normal operating hours. Approximately 12 hours per weekday were spent at the research site (06:00 to 18:00). Over week-ends, observations were for nine (9) hours (09:00 to 18:00) per day. A participant observation guide was designed using the literature to assist this process (Addendum E).

FIGURE 4.5: THE RESEARCHER AS A PARTICIPANT OBSERVER

This guide incorporated components of the food service systems model as well as, elements of total quality management, sustainability and food waste.

Participant observation method was particularly viewed as an important approach for this study as it complemented other qualitative methods of data collection that were applied. According to Roller and Lavrakas (2015), unlike any other qualitative data collection methods, participant observation can sidestep the potential error introduced by the faulty recall of events and information by the participants. The participant observation brought with it comprehensive, yet complex and new insights to the phenomena under investigation. The observation of the participants' actual practices gave the researcher an opportunity to gain an in-depth understanding and clarity of aspects raised during the face-to-face interviews and focus group discussions.

Creswell (2014:208) suggested that participant observation can be useful in exploring the investigation areas that may be uncomfortable for participants to discuss. In this case, the participants appeared uncomfortable with disclosing information regarding food waste. The participant observation procedure therefore, enabled the researcher to gain new themes of the investigation area, which were silent or not shared by the participants during the interviews. Additionally, the researcher was able to confirm the information that was generated during the interviews, as well as achieve the most objective experience of the study population (De Vos *et al*., 2011:328).

The following section discusses the participant observation method as applied in the study. The researcher's approach to participant observation is summarised diagrammatically in Figure 4.6 below.

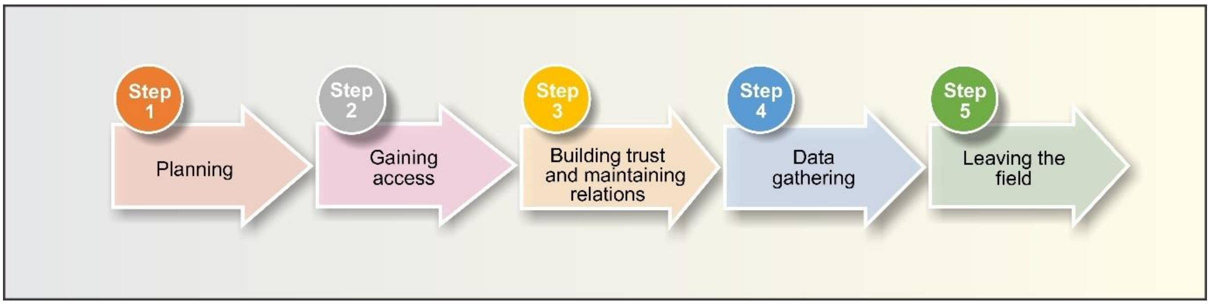


FIGURE 4.6: PROCESS OF PARTICIPANT OBSERVATION APPLIED IN THE STUDY

4.8.4.1 Planning

O'Leary (2014:234) suggested that to collect credible, valid and authentic data with rigour, it is crucial for researchers to plan the process before embarking on the participant observation approach. In the planning phase, the observation guide was developed and then piloted in four residential food service units of the University of Pretoria (Tuks Village, Kloostersaal, Nerina and Erica). Following the pilot test, the initial observation guide was amended followed by the study site (Tuks Monate) being accessed for observation.

4.8.4.2 Gaining access

Permission to enter the research area was obtained at the beginning of the research project. However, De Vos and colleagues (2011:333) found that permission granted at the beginning of the project does not entitle the researcher all the information. Any previous permission granted should be confirmed from time to time or when necessary. The researcher wrote a letter to both the Director of Food Services and the manager at Tuks Monate food service unit to request participant observation. Permission was granted and the researcher made contact with the food service workers or participants that were to be observed.

4.8.4.3 Building trust and maintaining relationships

According to De Vos *et al* (2011:333), gaining accurate and reliable information of participant observation depends to a large extent on the researcher having good relationships with the participants throughout the project. A trusting environment is essential for gaining accurate, truthful information that does not compromise the quality of the final data (Roller & Lavrakas, 2015:171). Where there is no trust, participants feel pressured and thus behave, act and give responses that are socially acceptable but not necessarily true. To build rapport in an effort to maximise the credibility of the data collected, the researcher made contact with the participants twice prior to the participant observation – after participant recruitment for observation and again a day before starting the participant observation. Roller and Lavrakas (2015:171) suggested that this preliminary contact initiates the rapport building between the participants and the researcher, who can then instil trust and legitimacy in the research process. This preliminary contact involved revealing information about the nature of the study, while being cautious not to reveal too much that may otherwise influence the participants' thoughts and actions. At some point during the observation process, the researcher realised that some participants were not welcoming. They saw the researcher as an intruder and an outsider. To address this and reinforce trust and good relationships, the researcher held rapport building sessions with the participants and assured them of confidentiality and anonymity of information. The researcher further stressed that the knowledge and practices of the participants were valuable, and that the researcher needed to learn from them.

4.8.4.4 Data gathering

The gathering of data involved a simultaneous process of actual observations and taking field notes. De Vos *et al*. (2011:335) recommended that it is beneficial to use standardised procedures in participant observation so as to maximise observational efficacy, minimise researcher bias and allow for verification of the data. Following this recommendation, the researcher used the observation guide throughout the process of the participant observation. The researcher noted and jotted down as much as possible that was seen and heard that related to the phenomena being investigated. However, at times it was inappropriate to be seen taking notes, such as when the researcher was carrying out food service duties like cooking and serving. In such a situation, the researcher made observations, made mental notes, and recorded observations once back in the office at the study site. To ensure accuracy of the data, the notes were converted into field notes on a daily basis at the end of each observation session (Bryman, 2012:451). As recommended by De Vos *et al*. (2011:335), field notes should contain a comprehensive account of the setting, activities taking place, the discussions and communication, and the participants' actions and behaviours. Besides these, the researcher noted personal impressions, perceptions and feelings experienced that may have clouded the observations (Goonan *et al*., 2014). Whenever necessary, brief conversations with the food service personnel were held to allow for clarification of aspects observed. Where possible, photographs documenting the practices and the food waste being investigated, were captured to complement the data collected.

4.8.4.5 Point of saturation and leaving the field

According to Creswell (2014:189), when gathering further data becomes repetitive, there are few new insights or when more or less everything is known about the topic, it indicates that the point of saturation had been reached. At this point, the researcher withdrew from further interaction with the study population.

4.9 QUALITATIVE DATA ANALYSIS AND INTERPRETATION

Using Braun and Clarke's (2012) guidelines, thematic analysis was electronically conducted using the ATLAS.ti software to analyse the qualitative data. The section below discusses

ATLAS.ti and justified its application for analysing the qualitative data in this study. This is followed by a discussion on thematic analysis.

4.9.1 Qualitative data analysis with ATLAS.ti

ATLAS.ti is a software package used to electronically analyse qualitative data (QDAS) gathered from the interviews, focus group discussions, documents, field notes and open-ended survey questions (Woods, Paulus, Atkins & Macklin, 2016). According to Smit (2002), ATLAS.ti is a powerful tool for analysing large chunks of text, visual and audio data. Given the large amount of unstructured audio and text data from the analysis of documents, interviews and observations that the researcher had to transcribe and analyse, the use of ATLAS.ti was considered appropriate (Smit, 2002). This next part of the study provides a brief background about the ATLAS.ti software, justifies its choice, discusses the weaknesses of the tool and how it was applied to analyse the data in the study.

4.9.1.1 Background of the ATLAS.ti software

'As early as the 1980s, qualitative researchers began to recognise the potential for computers to assist qualitative researchers' (Gilbert, Jackson & Di Gregorio, 2014:223). Thomas Muhr is credited (Gilbert *et al.*, 2014) for the development of ATLAS.ti as an interdisciplinary research tool (Frey, 2018:2).

4.9.1.2 Justification for choice of ATLAS.ti

ATLAS.ti was chosen for the analysis of the qualitative data for three reasons. First, the application of the computer assisted data analysis software (ATLAS.ti) was time saving and effective. It allowed the researcher to transcribe and analyse data within a shorter period of time than it would have taken doing it manually. Secondly, ATLAS.ti software has numerous functions that makes it easier to analyse qualitative data, for example; the transcription function allowed the researcher to adjust the volume and pace of audio recordings, which made it easy to transcribe. Thirdly, the use of computer assisted data analysis software renders qualitative research credible as the processes followed are transparent and replicable (Hwang, 2008).

4.9.1.3 Weaknesses of ATLAS.ti

It is argued that the use of QDAS, such as ATLAS.ti, can impose methodology procedures, such that research processes are conducted within the capacities of the software (Scales, 2013; Woods *et al.*, 2016). To avoid this pitfall, the researcher designed the data analysis processes so that the application of the software fitted the thematic analysis approach.

4.9.1.4 Process of computer-assisted analysis using ATLAS.ti

The process of computer-assisted analysis using ATLAS.ti consisted of various stages, diagrammatically illustrated in Figure 4.7 below. Computer-assisted analysis generally involves the preparation of data and creating a project file (*Hermeneutic Unit*), coding the data at different levels, and querying the data to discover patterns (Friese, 2019:1). This was done so that it was in line with the approach suggested for thematic analysis as discussed in the next section.

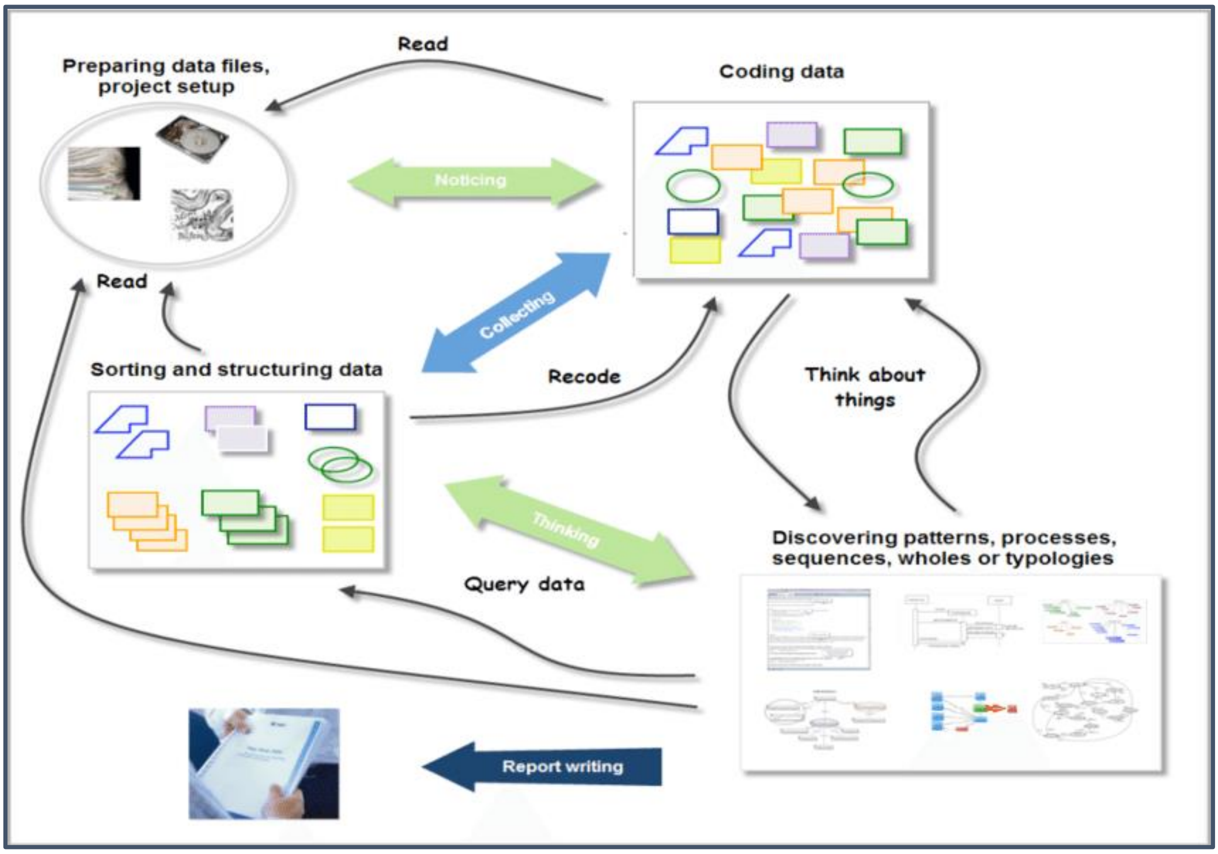


FIGURE 4.7: PROCESS OF COMPUTER-ASSISTED ANALYSIS USING ATLAS.ti (Friese, 2014:15)

4.9.2 Thematic data analysis

Thematic analysis is an analytic method that involves systematically identifying, analysing and recording patterns or themes emerging from the data (Braun & Clarke, 2012:57). The researcher followed a six-phase approach of thematic analysis (Figure 4.3) as discussed in the following section.

4.9.2.1 Phase 1: Familiarisation with data

The first step of the qualitative data analysis involved organising and preparing data for analysis. As highlighted above, the researcher used qualitative data analysis software, ATLAS.ti, to upload raw data in the form of text, audio and photographs, and transcribed the data. During this phase, the researcher studied the data repeatedly and actively read the transcripts to have a general sense of the meaning of the entire body of data (Braun & Clarke, 2012:60). The transcripts were read at least twice before the coding process. As the data was reflected on, general ideas emerged, including impressions of the overall depth, the credibility, and the tone of the participants (Creswell, 2014:197). The reflections were transcribed using the memo function on ATLAS.ti to aid the analysis process in subsequent phases.

4.9.2.2 Phase 2: Generation of initial codes

Coding is one of the most crucial steps in the analysis of qualitative data (Bryman & Bell, 2011:336). Bryman (2012:568) and Creswell (2014:197-198) described coding as the process of organising the data. This was done by bracketing chunks and assigning labels to component parts that are of theoretical significance or particularly salient to the phenomena being investigated. This phase involved the production of initial codes from the transcribed data using the ATLAS.ti software. During the coding process, the researcher constantly moved between the three main approaches of coding, as discussed in the following subsection:

- *Open coding*

This is 'the process of breaking down, examining, comparing, conceptualising and categorising data that yields concepts that are later grouped and turned into categories', (Bryman, 2012:569). The researcher studied the data to find underlying meaning from segments of the data. Using ATLAS.ti, the text to be coded was highlighted in the text browser, and new codes were created by right clicking on the highlighted text, selecting code and then clicking on open coding. This enabled the researcher to type the new codes. At this point, specific concepts (codes) were formulated from keywords used by the participants (emergent codes). Figure 4.8 (next page) illustrates an example of a coded transcript.

- *Axial coding*

'Axial coding is a set of procedures whereby data are put back together in new ways after open coding by making connections between categories, by linking codes to contexts, consequences, patterns of interactions, and to causes', (De Vos *et al*., 2011:412). Scott and

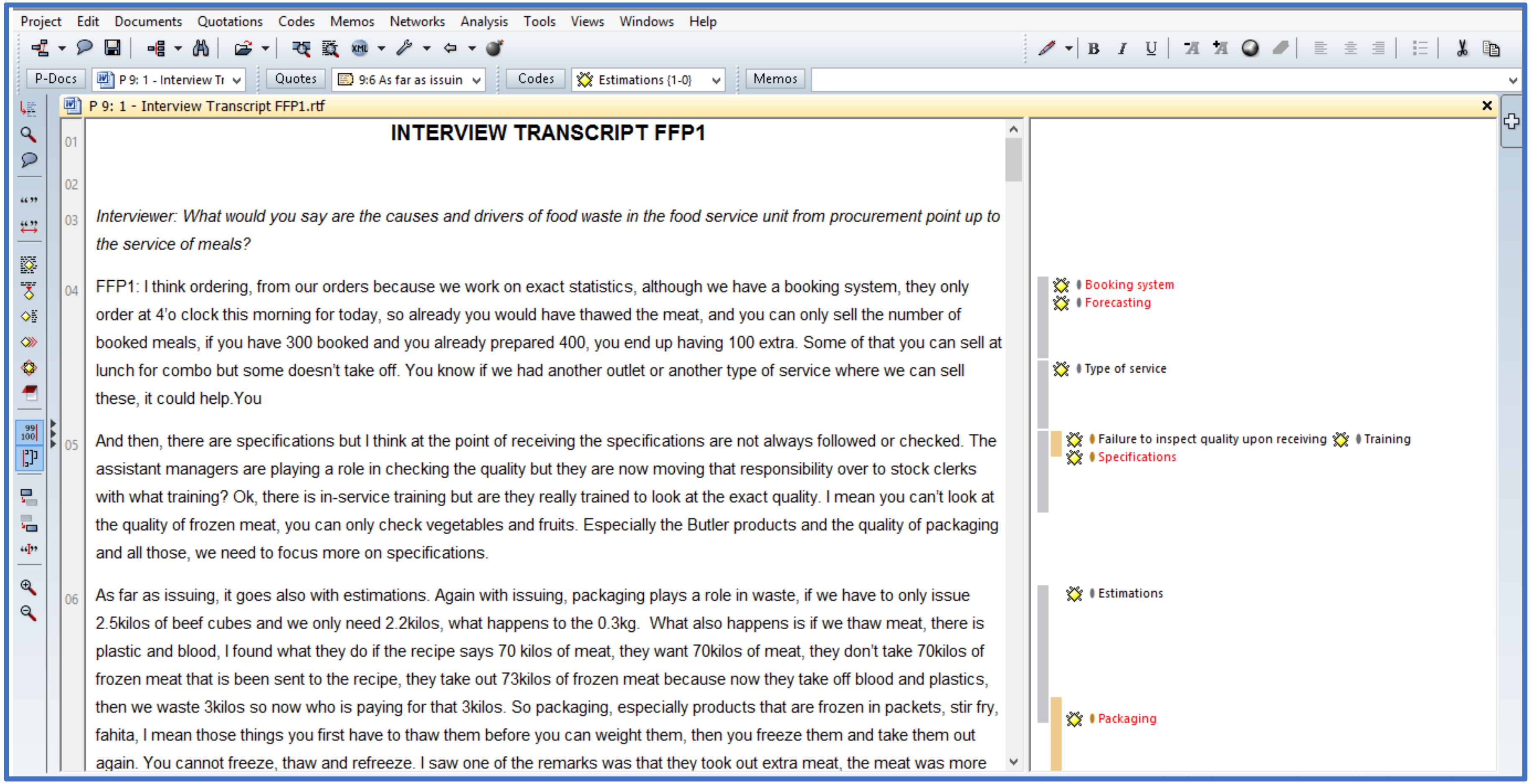


FIGURE 4.8: AN EXAMPLE OF A CODED TRANSCRIPT

Medaugh (2017) described axial coding as the second phase of the constant comparative analysis after open coding that analyses qualitative data for the purposes of theory development. In this study, axial coding involved categorising open codes into 'causes of food waste' and 'food waste prevention practices'. Axial coding included critically exploring the properties of the aspects mentioned, for example, whether forecasting practices generated food waste or prevented food waste or not.

- *Selective coding*

'Selective coding is the procedure of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development' (Bryman, 2012:569). In ATLAS.ti this was achieved through creating code families and also redefining codes, in other words, using the rename codes function (Smit, 2002). The codes that were identified were scrutinised in relation to the researcher's theoretical perspectives. The codes representing the causes of food waste were further grouped according to the subsystems of the food service system. The codes representing food waste prevention practices were categorised into dimensions of total quality management and dimensions of sustainable practices.

At the end of the second phase of the thematic analysis, all data, which had been initially coded, was developed into a comprehensive list of categorised codes. The next phase focused on searching for potential themes from the coded data.

4.9.2.3 Phase 3: Searching for themes

This phase involved re-focusing the analysis on broader levels of themes rather than codes (Braun & Clarke, 2006). Consideration was given to how the different codes could be combined to form a predominant theme (Braun & Clarke, 2006). Using ATLAS.ti, the researcher created themes using the "open family manager" function. Visual representations of thematic maps were used to sort different codes into themes (Figure 4.9). The codes were further analysed to form main themes and sub-themes related to the study, while the irrelevant codes were discarded. All extracts of data related to the themes were coded (Braun & Clarke, 2006).

4.9.2.4 Phase 4: Reviewing themes

This phase involved reviewing and modifying the potential or preliminary themes identified in the third phase (Braun & Clarke, 2006). The potential themes were checked for adequate supporting data and if these were meaningful (Maguire & Delahunt, 2017). All the collated data was reviewed to check for coherence across the themes and data. This ensured that the extracted data fitted into the themes to which they were allocated. Some sub-themes were re-assigned for example, food waste generation as a result of the type of packaging used was initially assigned to the procurement theme, but re-assigned to the inputs theme. The key questions that guided the review of the themes, as suggested by Braun and Clarke (2006), were as follows:

- Whether the theme was an actual theme or just a code?
- What was the quality and usefulness of the theme; did it tell anything about the data set, and did it have meaning in relation to the research objectives?
- What were the boundaries of the theme; what did it include and exclude?
- Was the data enough to support the theme?
- Was the theme coherent, and did it overlap with other themes?

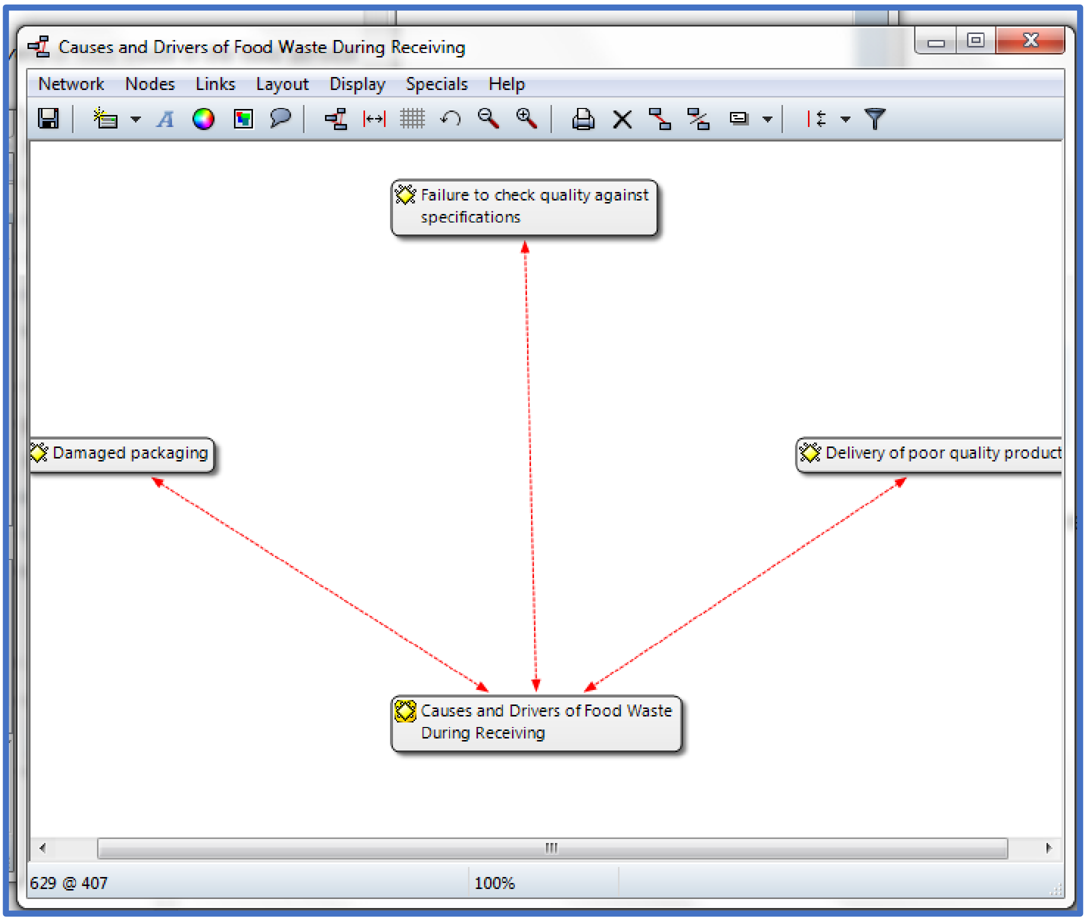


FIGURE 4.9: INITIAL THEMATIC MAP CREATED USING ATLAS.ti SOFTWARE

4.9.2.5 Phase 5: Defining and naming themes

Once a satisfactory thematic map of the data was developed in the fourth phase, themes were defined and further refined. According to Braun and Clarke (2012) defining and refining themes means clearly identifying the “essence” of each theme and determining what they are not. The researcher clearly defined the themes, selected extracts and analysed in detail those that would be included in the report.

4.9.2.6 Phase 6: Producing the report

The final phase of analysis involved writing the final thesis (Maguire & Delahunt, 2017). As suggested by Braun and Clarke (2006), the report was detailed, providing a logical, coherent and rich account of what the data suggested, including data extracts used as supporting evidence.

4.10 CONCEPTUALISATION AND OPERATIONALISATION OF THE DEVELOPMENTAL PHASE

Table 4.7 (next page) outlines the conceptualisation and operationalisation for Phase 2 to achieve the primary objectives 1 and 2 and the subobjectives. Table 4.7 (next page) indicates the most important concepts that guided the data collection in the second phase of the study. Table 4.8 indicates the dimensions and indicators of the main concepts.

4.11 QUALITY OF DATA

The issue of quality in qualitative research has been subjected to considerable debate over the years (Mays & Pope, 2006). In this study, a number of strategies to improve the quality of data were applied across four constructs; credibility, transferability, conformability and dependability (De Vos *et al*., 2011:419). In the following section the discussion is how quality was achieved once the qualitative data was collected and analysed during the second phase of the study.

4.11.1 Credibility

In the context of qualitative research, credibility or authenticity refers to internal validity where the researcher demonstrates that the inquiry was conducted in a manner that accurately represents and captures the true experiences of the participants (De Vos *et al*., 2011:419; Babbie, 2016:409). In this study, the following strategies ensured the credibility of the study:

4.11.1.1 Triangulation

Creswell and Miller (2000) defined triangulation as a validity procedure where multiple and different data collection methods or sources of information are used to build a coherent justification for themes. In this phase, the researcher applied several data collection methods, including face-to-face interviews, focus group discussions, document analysis and participant observation to obtain data from several sources and capture perspectives from various participants.

TABLE 4.7: CONCEPTUALISATION AND OPERATIONALISATION OF THE DEVELOPMENTAL PHASE

Primary objective 1: To investigate causes and drivers of food waste generation in the University's food service system.					
	Concept	**Dimensions**	**Indicators**	**Measuring instrument(s)**	**Data analysis**
	Causes of food waste in the food service system.	- Inputs. - Transformation. - Outputs. - Management. - Controls. - Memory. - Feedback. - Environmental factors.	*Tabulated in Table 4.8 below.*	Face-to-face interview guide: Q 1. Focus group discussion guide: Q1, Q2. Participant observation and document analysis guide: A_1, A_2, A_3, A_4, A_5, A_6, and A7.	Thematic analysis.
Primary objective 2: To develop a total quality management tool, integrating sustainability practices, which can be used to address food waste in University food service units.					
Sub-objective	**Concept**	**Dimensions**	**Indicators**	**Measuring instrument(s)**	**Data analysis**
2.1 To investigate total quality management practices that contribute to the prevention of food waste in university food service units.	Total quality management practices.	- Quality practices of top management. - Employee knowledge and education. - Employee management and involvement. - Information and analysis. - Supplier quality management. - Process quality management. - Customer focus. - Process and product quality design.	*Tabulated in Table 4.4 above (Phase 1).*	Face-to-face interview guide: Q 2, 5, 6. Focus group discussion guide: Q3, 4. Participant observation and document analysis guide: B_1, B_2, B_3, B_4, B_5, B_6, B_7, and B_8.	Thematic analysis.
2.2 To explore sustainability practices that university food service units can implement to address food waste.	Sustainability practices.	- Sustainable food practices. - Environmental sustainability.	*Tabulated in Table 4.4 above (Phase 1).*	Face-to-face interview guide: Q7, 8. Focus group discussion guide: Q5. Participant observation and document analysis guide: C_1, C_2.	Thematic analysis.

TABLE 4.8: INDICATORS OF DIMENSIONS OF FOOD WASTE IN THE FOOD SERVICE SYSTEM

Concept	Dimensions	Indicators
Causes of food waste in food service systems	Inputs	Human: skills, knowledge. Materials: food, supplies. Facilities: space, equipment. Operational: time, energy, water, information.
	Transformation	Management functions. Linking processes. Functional subsystem.
	Outputs	Meals quantity. Meals quality. Customer satisfaction. Financial accountability.
	Controls	Standards. Policies and procedures. Plans. Contracts. Laws and regulations.
	Memory	Financial records. Inventory records. Forecasting. Personnel records. Meal statistics. Recipes. Menus.
	Feedback	Food waste generation information. Information from feedback mechanisms.
	Environmental factors	Factors such as: social; economic; technological; demographic; and political factors.

4.11.1.2 Respondent validation

Respondent validation or member checking involves the comparison of the researcher's account with those of the research participants to establish if the two sets of data correspond (Mays & Pope, 2006). To establish the accuracy of the findings using this technique, the researcher wrote a report of the major findings to the participants and provided them with an opportunity to comment on the content. The participants confirmed that the findings were a true reflection of the information they had shared of their experiences.

4.11.1.3 Prolonged engagement in the field

Another validity procedure was a prolonged stay of five months, from July to November 2016, at the research site. Creswell and Miller (2000) suggested that repeated observations during a prolonged engagement in the field, enables the researcher to build trust and rapport with the participants. This enables them to feel comfortable to disclose information. A prolonged stay at the research site allowed the researcher to corroborate the data collected during the interviews with the observational data.

4.11.2 Transferability

Transferability refers to the applicability of research findings in other contexts or whether findings of the study can be transferred from the specific situation of the current research to another (Treharne & Riggs, 2014). In this study, to facilitate transferability judgement by other users, detailed descriptions and purposive sampling were applied.

4.11.2.1 A rich, detailed description

A rich, detailed description of the setting, events and perspectives about the themes is included in the findings and discussion chapter. This allows readers to draw their own conclusions, and if the situations described in the study are similar to theirs, findings can be related to their own position (Leedy & Ormrod, 2001:101).

4.11.2.2 Purposive sampling

According to Anney (2015), purposive sampling can enhance a study's transferability. In this study, the participants were purposively sampled. This provided greater in-depth findings as they were particularly knowledgeable and experienced with the issues investigated (Anney, 2015).

4.11.3 Confirmability

Conformability refers to the degree to which findings of the study could be corroborated by other researchers (De Vos *et al.,* 2011:421). Specifically, 'it is concerned with establishing that data and interpretations are not figments of a researcher's imagination, but are clearly derived from the data', (Anney, 2015:279). Confirmability of the study was achieved through triangulation.

4.11.4 Dependability

According to Anney (2015), dependability refers to the stability of the findings over time or the extent to which similar findings would be produced if a different researcher undertook a similar study using similar procedures. Dependability was established using triangulation in the manner discussed above.

4.12 ETHICAL CONSIDERATIONS

Five important ethical issues were considered when collecting the data during the second phase of the study. These are discussed below.

4.12.1 Protection from harm

The protection of the participants from emotional and psychological harm was ensured, by careful and sensitive phrasing of the questions that may have otherwise subjected them to unusual stress, embarrassment or guilt (Leedy & Ormrod, 2001:120). The researcher specifically ensured that the questions about food waste generation were phrased so that the participants did not feel responsible nor guilty. The protection of the participants from harm was also addressed by maintaining the confidentiality of the records (Bryman, 2012:136). The participants were protected from physical harm by ensuring they did not handle any hazardous food waste. Any form of food waste was disposed of immediately after the research investigations.

4.12.2 Voluntary and informed participation

The researcher ensured the participants understood the face-to-face interviews, focus group discussions and participant observation and any other procedures related to the study. They were given the choice of either participating or not (Addenda F, G and H). They were informed that any form of participation was strictly voluntary, they were not obliged to participate in the study and under no circumstances should feel pressurised to do so by employers or other more powerful individuals. Furthermore, the researcher emphasised that they had the right to withdraw from the study at any time (Bryman, 2012:138). The researcher obtained signed, written consent letters from the participants prior to implementing the focus group discussions and face-to-face interviews.

4.12.3 Privacy, confidentiality and anonymity

According to Leedy & Ormrod (2001:121), when research involves the use of human beings, their rights to privacy, confidentiality and anonymity should be respected. The findings of the study were presented anonymously. All elements of confidentiality were clear in the consent form. It was made explicitly clear with a detailed statement that the raw data provided by the participants would only be accessible to the researchers involved in the study. The researcher ensured that the participants' responses were not revealed to the management of the food service operation, other staff members nor anyone else other than co-researchers who had a significant role in the research investigation.

4.12.4 Ethical clearance

In addition to the ethical aspects discussed, the researcher sought ethical clearance; reference number 160205-006 (Addendum I) to conduct the study. This was from the Faculty of Natural and Agricultural Sciences' Research Ethics Committee of the University of Pretoria. The requirements were strictly adhered to.

4.12.5 Permission to access research site

Permission was sought from the Director of Food Services at the University of Pretoria to conduct the research, and to access the research site and participants (Addendum A). A further request was made to the Food Service Manager at Tuks Monate (research site) to meet the participants at specific times. The research procedure was clearly discussed with the Director of Food Services and the responsible Food Service manager so that they fully understood the nature of the study and possible implications on the daily operations of the research site.

PHASE 3: VALIDATION PHASE

The aim of this phase was to validate the tool developed to address food waste in the University food service units using the e-Delphi technique. The literature indicates that the e-Delphi method has been widely used for the validation of tools; for example, Löfmark and Mårtensson (2017) applied the Delphi method in a study validating the assessment tool for clinical education. In another study, Smith and Simpson (1995), used the e-Delphi method to validate teaching competencies of faculty members in higher education. In the sections below, the discussion is how the e-Delphi method was applied in this study. Specifically, there is a discussion on sampling procedures, how the expert panel was recruited and selected, and the composition of the panel, the methodology procedure, data analysis, reliability and validity as well as ethical considerations.

4.13 THE e-DELPHI TECHNIQUE

The e-Delphi technique is a structured iterative process in which a survey is used to gather information from recruited experts (Sharkey & Sharples, 2001). Each stage builds on results of the previous one. A series of rounds are used to gather information until consensus is reached (Morgan, Chittleborough & Jorm, 2016). Hasson and Keeney (2011:1696) described the e-Delphi technique as a systematic collection and aggregation of informed judgement from a group of experts on the specific phenomena being investigated. The aim of this technique is to reach consensus from a panel of experts (Sharkey & Sharples, 2001).

Several components of the e-Delphi technique made it suitable for this study. First, since the standard format of the e-Delphi technique does not require participants to meet, it avoids problems inherent in face-to-face interactions, such as group conflict and individual dominance (Grisham, 2009; Morgan *et al*., 2016). Morgan *et al*. (2016) further argued that the controlled feedback and anonymity characterised by the e-Delphi technique, increases the reliability of consensus. Secondly, the e-Delphi technique is characterised by multiple iterations of inquiry, which allows the participants time to reflect and an opportunity to modify their responses in subsequent rounds (Hsu & Sandford, 2012). Thirdly, the e-Delphi technique was chosen as a means to generate ideas from experts in the field of total quality management and sustainability, since the literature in these areas and in the context of food service units is limited (Fefer, De-Urioste Stone, Daigle & Silka, 2016; Hsu & Sandford, 2012).

4.14 RECRUITMENT AND SELECTION OF EXPERTS

The selection of appropriate participants is considered the most important aspect of the e-Delphi technique. The dependability of generated data, the validity of the e-Delphi technique and the quality of results depend largely on the quality of the opinions elicited from the expert panel (Alshehri, Rezgui & Li, 2015; Hsu & Sandford, 2012; Wang *et al*., 2013). According to Alshehri *et al*. (2015:2226), four basic requirements should be considered when selecting experts; these include; (a) the knowledge and experience of the participant of the topic being investigated, (b) their ability and willingness to participate, (c) adequate time to participate, and (d) effective communication skills. The selection of the e-Delphi experts was thus guided by the following inclusion criteria:

a. At least two (2) years' post-qualification experience and sufficient knowledge in the area of food waste, total quality management and sustainability in the food service sector;
b. At least a degree in the field of food service, total quality management, environmental science or related studies;

c. Regular access to a computer and the Internet as the e-Delphi technique is web based;
d. Adequate time and willingness to participate; and
e. The ability to read and write in English.

The selection of the participants for this particular e-Delphi process applied both purposive- and snowball sampling. Experts included those who were well known in the field of the investigation and whose profile appeared in organisational databases and websites. These included university websites, and the Purchasing Consortium Southern Africa (PURCO SA). This is a non-profit higher education group-purchasing consortium representing all South African public universities. If the persons met the set selection criteria they were invited to participate in this study (purposive sampling). This initial population was requested to identify and suggest other experts, who could be invited to participate in the study (snowball sampling). The recruitment process showed that the number of food service experts in the South African University residential food service units was very low which limited the sample size of the study. Additionally, the study was limited to the 26 public universities in South Africa. An email (Addendum J) was sent to 33 potential experts at 26 tertiary South African institutions inviting them to participate. From this list, 17 indicated their willingness, while 16 experts either declined or did not respond. An email with the link to the survey was sent to the willing participants (Addendum J). A total of nine (9) experts completed the first run of the survey, resulting in a response rate of 53%. To address the low response rate, the researcher sent an email reminding the potential participants to complete the survey (Addendum K). The literature (Fernández-Ávila, Rojas & Rosselli, 2020; Trevelyan & Robinson, 2015) on the Delphi technique illustrates that the appropriate sample size for a Delphi study is not predefined but in general the number ranges between 7 and 30. Other studies (Hsu & Sandford, 2007; Musa, Yacob, Abdullah & Ishak, 2015) show that a sample size of four (4) and above is sufficient for a Delphi study.

4.15 EXPERT PANEL COMPOSITION

A total of nine (9) experts from industry, academia, and researchers participated in the study. The demographics of the expert panel are shown in Table 4.9 (next page) and their professional information is in Table 4.10 (next page).

TABLE 4.9: DEMOGRAPHIC INFORMATION OF THE e-DELPHI PANEL

Characteristic	*n*	%
Gender		
Male	1	11.1
Female	8	88.9
Age (years)		
30 - 39	1	11.1
40 - 49	3	33.3
50 - 59	3	33.3
60 +	2	22.2
Educational Background		
Undergraduate	2	22.2
Postgraduate	7	77.7

TABLE 4.10: JOB POSITION INFORMATION OF THE e-DELPHI PANEL

Area	Organisation	Job Position	Years of Experience
Academic	Tshwane University of Technology	Lecturer	30
	University of Pretoria	Lecturer	8
	Stellenbosch University	Lecturer	18
University Food Service	University of Pretoria	Food service manager	24
	University of Pretoria	Food service manager	12
	University of Pretoria	Administrative officer	36
	Private	Food service manager	36
University Student Residence	University of the Western Cape	Manager (Placement & Administration)	10
Research	Council for Scientific and Industrial Research (*CSIR*)	Research Scientist (Food waste and sustainability)	8

4.16 METHODOLOGY PROCEDURE

It is important to note that there are different types of e-Delphi approaches. For this study, a modified web-based e-Delphi technique was applied. A web-based survey using Qualtrics software was adopted to administer the e-Delphi questionnaire, which had pre-selected components, indicators from the literature, and qualitative data of the first and second phases (Hasson & Keeney, 2011). There were two rounds of the e-Delphi survey from June 2018 to April 2019. The researcher decided to stop the polling after two rounds because there was a strong convergence of opinions and also because there was a reduction in the number of experts participating in the second round. Each e-Delphi round consisted of data collection and analysis. The first round of the survey was followed by the development of a new questionnaire for the second round (Fefer *et al*., 2016). The following sections indicate how the e-Delphi process was conducted, and is illustrated in Figure 4.10 below.

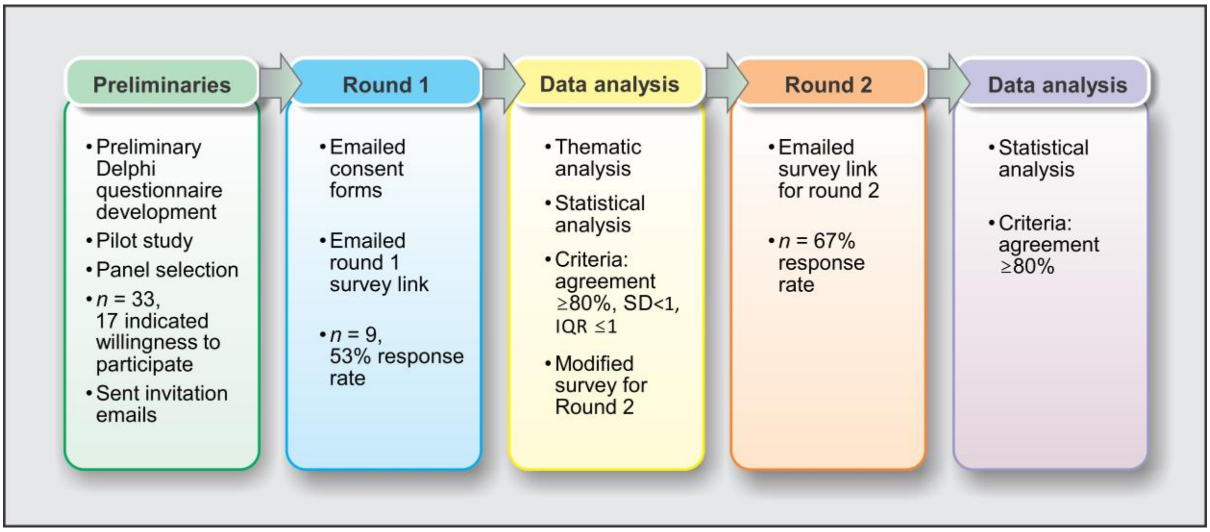


FIGURE 4.10: THE e-DELPHI PROCESS USED IN THE STUDY

4.16.1 Development of the e-Delphi questionnaire and pilot testing

A preliminary questionnaire was developed from the findings of the first and second phase. A pre-test pilot study was distributed to a total of five (5) individuals in academia and the University food service units, prior to the main e-Delphi survey. Suggestions, additions and deletions from the pre-test pilot were used to improve the quality and clarity of the survey.

4.16.2 e-Delphi round 1

The first run of the e-Delphi process (Addendum L) consisted of both open- and close-ended question based on the insights of the literature review and qualitative analysis of the first and second phases (Fefer *et al*., 2016). The participants were asked to evaluate the importance of each of the components and indicators of total quality management and sustainability practices on food waste prevention (Wang *et al*., 2013). The researcher used a 5-point Likert scale as it provided a more accurate measure of a participant's true evaluation (Alshehri *et al*., 2015). On a Likert scale of 1 to 5, the participants were requested to rate the importance of the items listed; 1 being the least important and 5 the most important. The participants were given an opportunity to add or modify items on the preliminary list. They could provide further suggestions about the phenomena being investigated and/or offer comments on the responses (Ogden, Culp, Villamaria & Ball, 2016; Sharkey & Sharples, 2001).

4.16.3 e-Delphi round 2

For the second run of the e-Delphi process, the questionnaire was modified based on the results of the first round (Wang *et al*., 2013). A new list of components and indicators of TQM and sustainability practices, where consensus had not been reached, as well as additional indicators suggested were sent to experts for re-evaluation of their importance (Addendum M). The participants were asked to re-rate the importance of each item, using the 5-point Likert scale, and to justify their ratings (Bentley, Kerr & Powell, 2016).

4.17 DATA ANALYSIS

Thematic analysis was used to analyse the open-ended responses of round 1 (Wang *et al*., 2013). New statements suggested by the expert panel were added. As suggested by Kim, Njite & Hancer (2013), similar statements with the same meaning were collapsed into a single statement. Quantitative data from rounds 1 and 2 of the e-Delphi process were analysed using SPSS, version 24, statistical analysis software. The literature on the Delphi technique demonstrates that different statistical measures are used to define consensus across Delphi studies and no agreement exists on which is the best criteria to use (Holey *et al*., 2007; Morgan *et al*., 2016). However, percentage agreement is most frequently used to assess consensus (Chang, Gardner, Duffield & Ramis, 2010; Estrela, Roque, Silva, Zapata-Cachafeiro, Figueiras & Herdeiro, 2021). In the first round the percentage agreement, standard deviation and interquartile range were used to measure the consensus of the indicators (Bentley *et* al., 2016, Wang *et al*., 2013). Indicators with a level agreement ≥ 80%, standard deviation <1, and an interquartile range ≤1 were considered to have reached consensus and agreement that they were important in reducing food waste (Alshehri *et al.,* 2015; Efstathiou, Coll, Ameen & Daly, 2011; Morgan *et al*., 2016; Wang *et al*., 2013). In the second round, only the level of percentage agreement (≥ 80%) was used to assess consensus as the sample size was too small to allow application of other statistical measures. The standard deviation and interquartile range were not applied to analyse data in this second run since the small sample size increased the margin of error and decreased the statistical power. In this regard, the data analysis approach followed in this part of the study contributes to the methodology.

4.18 RELIABILITY

Consideration must be given to issues of reliability when undertaking any research study (Hasson & Keeney, 2011). Reliability is defined as the extent to which a research method produces consistent results (Bryman & Bell, 2011:36). The researcher applied the following strategies to achieve reliability.

4.18.1 Conceptualisation and operationalisation

As suggested by Neuman (2007:116), reliability is improved by clearly conceptualising all constructs, which contribute to the precision and accuracy of the data captured. The researcher developed unambiguous, clear theoretical definitions for all important constructs in the study.

4.18.2 Pilot testing

According to Neuman (2007:117), reliability can be improved by pre-testing an instrument before it is used in the main investigation. The e-Delphi survey was pilot tested to improve the quality of the instrument and eliminate ambiguity of any questions, such as those that may have led to biased responses, and vague questions that may have led to vague answers (De Vos *et al*., 2011:195).

4.19 VALIDITY

'Validity refers to the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration' (Babbie, 2016:148). To ensure validity, in this phase, following types were applied.

4.19.1 Face validity

Face validity is the degree to which a procedure or instrument appears "valid", that is, whether the instrument measures what it is supposed to measure (Bryman & Bell, 2011:38). To ensure face validity, experts, including the researcher's doctoral supervisors from the Department of Consumer and Food Sciences, Food Management doctoral students and Operations Managers in the Food Service Division of the University of Pretoria, were requested to assess the items of the survey and whether the measure captured the concept that was the focus of attention.

4.19.2 Content validity

Content validity refers to the extent to which the instrument covers the complete content of the particular construct that it sets out to measure (Maree, 2007:13). The researcher assessed the logical link between the variables included in the measuring instrument and the study objectives through operationalisation (Wilson, 2010). The researcher requested the same experts, who had assessed face validity, to evaluate the extent to which each item of the measuring instrument was adequately represented (Brink, Van der Walt & Van Rensburg, 2006). The methodology literature indicates that the e-Delphi process itself adds to the content validity of the tool. The continual succession of rounds allows researchers to judge and review scale items generated throughout the process (Hasson & Keeney, 2011).

4.20 ETHICAL CONSIDERATIONS

Like any other data collection procedure, an e-Delphi survey is subject to ethical considerations. Ethical approval (reference: 160205-006) was sought and granted by the Faculty of Natural and Agricultural Sciences Research Ethics Committee of the University of Pretoria. The researcher adhered strictly to the requirements of the Research Committee. Written consent forms were emailed to the panel experts before commencing the study (Addendum N). It was clearly stipulated that participation was voluntary and they could withdraw at any time. The participants were also informed that all data would be anonymous throughout the research process.

4.21 CONCEPTUALISATION AND OPERATIONALISATION

Table 4.11 (next page) shows the operationalisation for the third phase of the study. The most important concept addressed in this phase is the validation of the tool. To achieve the objective, an e-Delphi technique was applied. Both thematic analysis and statistical measures were applied to analyse the data.

4.22 SUMMARY

In this chapter, the methodology was discussed, which included the research design and methodology applied to achieve the aim and goals of the study. The study followed a multiphase mixed method design entailing the phases of predevelopment, development and validation. The first phase focused on the development of the indicators of total quality management and sustainable practices from the systematic literature review. The second phase further investigated these areas in the specific context of the University residential food service units. Qualitative data collection methods including document analysis, face-to-face interviews, focus group discussions and participant observation were applied. The third phase used an e-Delphi technique to validate the tool developed in the second phase. Both qualitative and quantitative data analysis were applied to analyse the data that was collected.

TABLE 4.11: CONCEPTUALISATION AND OPERATIONALISATION OF VALIDATION PHASE

Primary objective 3: To validate the developed total quality management tool integrating sustainability practices, which can be used to address food waste in University food service units.				
Concept	**Dimensions**	**Indicators**	**Measuring instrument**	**Data analysis**
Validation of the tool developed.	- Quality practices of top management. - Employee knowledge and education. - Employee management and involvement. - Information and analysis. - Supplier quality management. - Process quality management. - Customer focus. - Process and product quality design.	*Tabulated in* *Table 4.4 above (Phase 1)*	e-Delphi survey round 1 Q 7 – Q 40. e-Delphi survey round 2 Q1 – Q32.	Thematic analysis. Statistical analysis: - Percentage agreement. - Standard deviation. - Interquartile range.
	- Sustainable food practices. - Environmental sustainability.			

The subsequent chapters present the findings for all the objectives of the study.

Chapter 5:

CAUSES OF FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SYSTEM

Chapter 5

CAUSES OF FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SYSTEM

This chapter presents findings addressing the first objective, which was an investigation of the causes of food waste in the University food service system.

5.1 INTRODUCTION

Despite the rapidly increasing literature on the issue of food waste, only a few studies have placed emphasis on the causes of food waste in the University food service system. The chapter presents the findings and interpretation of data obtained from document analysis (D), face-to-face interviews with managers (I), focus group discussions (FG) with front-of-house and back-of-house staff, and participant observations (O). These datasets informed the study on the causes of food waste in the University food service system, and in the context of South Africa. Unlike previous studies, a holistic view of the causes of food waste in the different parts of the University food service system (Figure 5.1) was explored. An understanding of food waste from this perspective was useful in developing a tool that addressed food waste in the entire food service system.

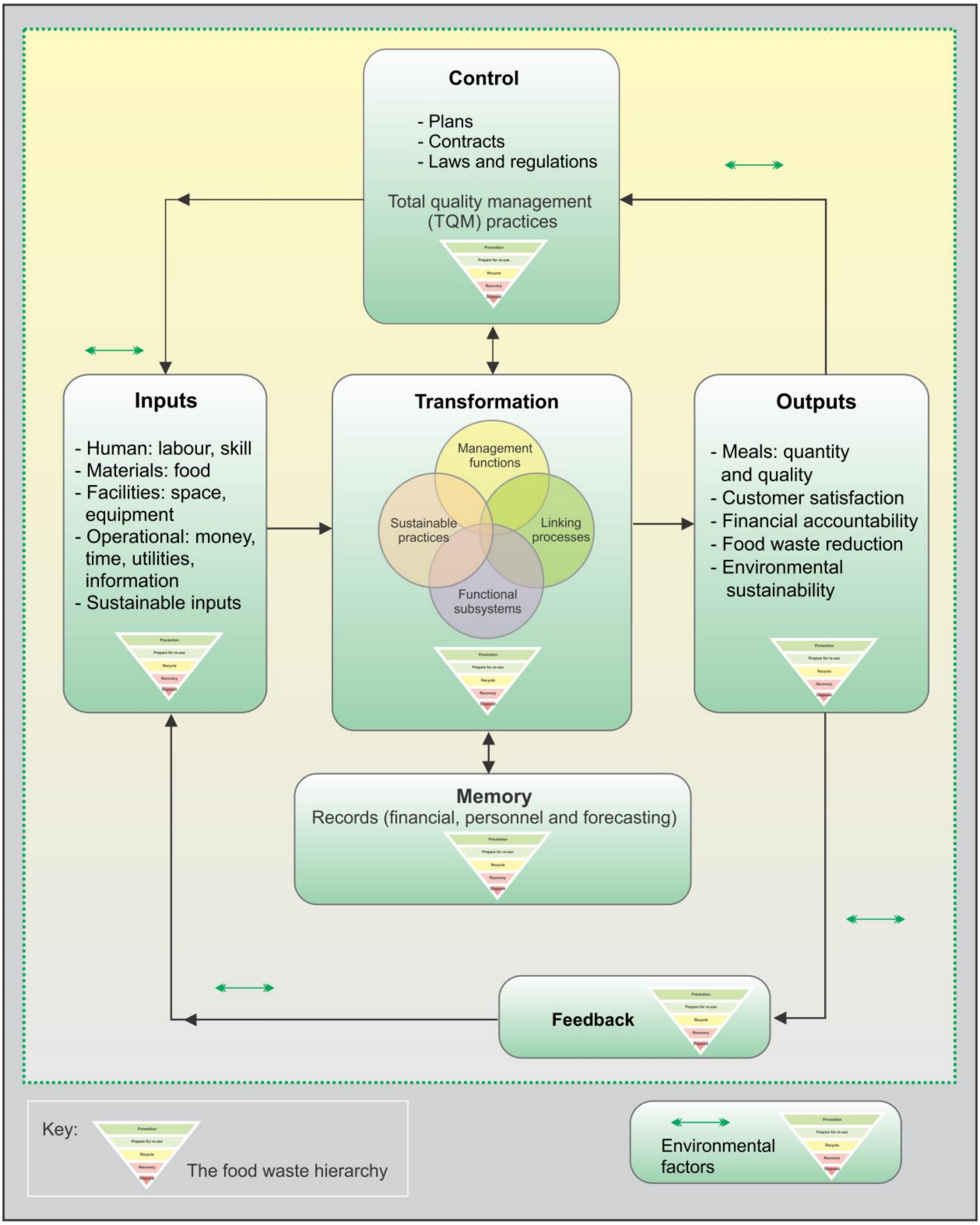


FIGURE 5.1: A FOOD SERVICE SYSTEMS MODEL

The key findings that emerged from the data analysis are summarised and presented in Table 5.1 (next page). The table provides an integration of the data from different sources applied in this study.

TABLE 5.1: SUMMARY OF KEY FINDINGS FROM DIFFERENT DATA SOURCES

Subsystems / component	Elements of the system	Main findings	Methodology applied			
			D	O	I	FG
Inputs	*Human*	Lack of professional skills and knowledge.	✓	✓	✓	✓
		Negative attitudes of food service workers.		✓	✓	✓
	Raw materials	Packaging of ingredients.				
		• Inappropriate packaging size.		✓	✓	✓
		• Difficult to empty food package.			✓	✓
		The use of preprepared ingredients.	✓	✓	✓	✓
		Poor quality ingredients.		✓	✓	✓
	Facilities	Lack of appropriate equipment.		✓	✓	✓
	Operational time	Strict meal serving times leading to discarding of unserved meals.	✓	✓		✓
Transformation	***Functional subsystem***					
	Purchasing	Procurement of unpopular food items.	✓		✓	
		Overstocking.	✓	✓	✓	
	Receiving	Failure to check quality against specifications.		✓	✓	
		Failure to promptly transfer perishables from the receiving area to storage area.		✓		
	Storage, inventory control and issuing	Improper storage of food supplies.		✓		✓
		Failure to store food at the correct temperatures.		✓	✓	✓
		Failure to follow inventory and stock rotation methods such as FIFO (First-in/First-out).		✓		✓
		Failure to date mark food during storage.		✓		
		Failure to strictly adhere to food storage requirements.			✓	
		Failure to control pests in the storage areas.			✓	

continues …

Subsystems / component	Elements of the system	Main findings	Methodology applied			
			D	O	I	FG
		Failure to weigh food during the process of issuing.			✓	
		Incorrect measuring of ingredients during issuing.			✓	
	Production	Overproduction.	✓	✓	✓	✓
		Overcooking or burning of food items during cooking as a result of improper temperature control.	✓	✓	✓	✓
		Inaccurate measurement of food during production.		✓		✓
		Ingredient preparation (peeling, trimming and cutting).		✓		
		Discarding excess food during production.		✓		
	Distribution and service	Lack of communication about held food.		✓		✓
		Prolonged hot holding times.		✓	✓	✓
		Holding excess food longer than required.		✓		✓
		Quality loss during holding.	✓	✓		
		Incorrect reheating practices.	✓	✓		✓
		Centralised and decentralised delivery-service system.		✓	✓	✓
		Commissary food service system.		✓		✓
		Buffet service style.			✓	
		Cafeteria service style.		✓		✓
		Inaccurate or inconsistent portioning.	✓	✓	✓	✓
		Food spillages.		✓		✓
	Management functions *Planning*	The goal to provide nutritionally adequate meals, resulting in wastage of vegetables.		✓	✓	
		Cost reduction objective resulting in wastage of food chosen on the basis of price not quality.			✓	✓

continues …

Subsystems / component	Elements of the system	Main findings	Methodology applied			
			D	O	I	FG
		Policy restrictions.	✓	✓		
		Failure to adhere to policy requirements.	✓	✓	✓	
		Lack of adherence to standard operating procedures (SOPs).		✓	✓	
	Organising	Assigning duties on rotational basis instead of specialisation.			✓	
		Feeling unaccountable for waste.		✓		✓
	Staffing	Recruitment and selection of untrained staff.		✓		✓
		Lack of in-service training.		✓	✓	
	Directing	Failure to give clear instructions to food service workers.				✓
		Inconsistencies in directing food service workers.		✓		✓
	Coordinating	Lack of routine food waste monitoring.	✓	✓		
	Reporting	Lack of or poor reporting.	✓	✓	✓	
	Budgeting	Limited or restricted budget.	✓		✓	
	Linking processes	Ineffective communication across different levels of food service workers.			✓	✓
	Communication	Lack of communication between the food service unit and customers.			✓	✓
	Decision-making	Minimal involvement in decision-making.		✓	✓	✓
		Failure of top management to empower lower management and allow them to make programmed decisions.			✓	
	Balance	Difficulty in balancing policy requirements.			✓	✓
Control		Fixed menu for booked meals.	✓	✓	✓	✓
		Failure to adhere to contractual agreements.		✓	✓	
		Strict meal plan agreements.		✓	✓	✓

continues …

Subsystems / component	Elements of the system	Main findings	Methodology applied			
			D	**O**	**I**	**FG**
		Failure to adhere to quality controls.			✓	✓
Memory		Inaccurate forecasting.	✓		✓	
		Inaccurate recording of leftovers and food wasted.	✓	✓		
		Production based on inventory records not number of forecasted customers.	✓	✓	✓	
Outputs		Excess quantity of meals produced.	✓	✓	✓	✓
		Poor meal quality.		✓		✓
		Customer dissatisfaction.				✓
		Lack of financial accountability.		✓	✓	
Feedback		Ineffective implementation of the meal complaint system.				✓
		Failure to share feedback on waste generation between food service workers and management.		✓		✓
		Failure to put feedback mechanisms for staff in place.				✓
Environmental factors	*External environmental factors*	Policies limiting utilisation of leftovers.	✓	✓	✓	✓
		Content and appeal of competitors' menu.				✓
		Varying needs of students according to demographics.		✓	✓	✓
		Students' busy lifestyle.			✓	✓
		Irregular demand due to weather variations.		✓		✓
	Internal environmental factors	Technological failures.			✓	
		Unskilled staff.			✓	
		Lack of predictability of number of customers due to University events.			✓	✓

5.2 CAUSES OF FOOD WASTE IN THE FOOD SERVICE SYSTEM

This section presents causes of food waste identified at the case University food service unit. These causes are discussed from a systems perspective following the framework presented in Figure 5.1. The food waste hierarchy framework was integrated, considering the food waste management options adopted by the University food service system at each point where food waste was generated. The analytical discussion includes drawing sustainability implications of practices causing food waste, as well as the food waste management approaches that are implemented.

5.2.1 Inputs

The findings of the study showed that inputs of a food service system have an influence on food waste generation. The next section discusses specific aspects of the inputs that were found to have an influence on food waste generation in the University food service unit.

5.2.1.1 Human resources

Two aspects related to human resources were established as contributing factors to food waste generation in the University food service unit. These are a lack of professional skills and attitudes of food service workers.

- *Professional skills*

Although most of the food service workers at operational level did not possess professional qualifications relevant to food service, some demonstrated competency over others (FG, O). Food service workers, who had a considerably long work experience at the University food service unit, exhibited proficiency in the execution of their work. Those who lacked professional skills, and did not undergo in-service training, were more inclined to make mistakes during the execution of activities in different areas of the food service system, which led to food waste (I, O). For instance, untrained receiving personnel, who lacked knowledge of food specifications and quality evaluation, received food items that did not meet the quality specifications, which led the food service unit to absorb waste instead of rejecting and returning the items to the suppliers (I). One of the participants pointed out that even though the University food service unit has control measures, such as food specifications, they are not always followed as staff members were not trained on their application (I):

> *"… there are specifications but I think at the point of receiving, the specifications are not always followed or checked. The assistant managers are playing a role*

in checking the quality but they are now moving that responsibility over to stock clerks with what training"?

This is in line with the findings made by Charlebois *et al*. (2015), whose study showed that under-trained employees at Delish restaurants in Canada, were unable to determine defects or poor quality deliveries, hence creating food waste for the restaurants. From the statement made by the participant, who made the above statement, it can be concluded that some food service workers in supervisory positions with the necessary professional skills, contributed to the generation of food waste by shifting their responsibilities to the food service workers, who had no relevant training.

The findings further showed that the lack of professional skills led to errors, which resulted in food waste at different stages of the University food service system (O). For example, at the production stage, cooks or chefs, who lacked professional skills, made mistakes, such as misinterpreting or disregarding instructions specified in standardised recipes, incorrect measuring of ingredients and failure to execute some general tasks of food production, such as preparation, cooking and use of specialised food production equipment (O, I). This resulted in production errors and failure to produce good quality food products, hence the generation of food waste. For instance, it was observed that during pizza production, 4.5 kilograms of flour was used instead of 13.5 kilograms as specified in the recipe (O, D). All the other ingredients were measured in the correct proportions for the 13.5 kilograms of flour. This resulted in a poor-quality pizza base; too yeasty, too salty and too dry, which ended up being disposed of (Figure 5.2). In agreement with the findings of this study, Heikkilä *et al*. (2016) indicated that employees' incompetence of general tasks carried out in the food production process, such as the inability to correctly read and interpret recipes, failure to estimate and order suitable amounts, contributed to the creation of kitchen waste.

Taking into account the interdependency nature of the food service system, the lack of professional skills or incompetence among food service workers, somewhat affected the performance of other parts of the system and food waste generated thereof. For instance, even though control measures, such as food specifications, were developed and available, they were not always followed or implemented, due to a lack of knowledge by food service workers, which led to food waste. Similarly, the supply and acceptance of poor-quality ingredients under the procurement subsystem, caused food wastage at the storage, production and service subsystems. This interdependency is shown in Figure 5.3. Past research does not clearly show the interdependency of subsystems and how these contribute to food waste generation. This research contributes to the literature in this regard.

FIGURE 5.2: POOR QUALITY PIZZA BASE DUE TO LACK OF PROFESSIONAL SKILLS AND COMPETENCE

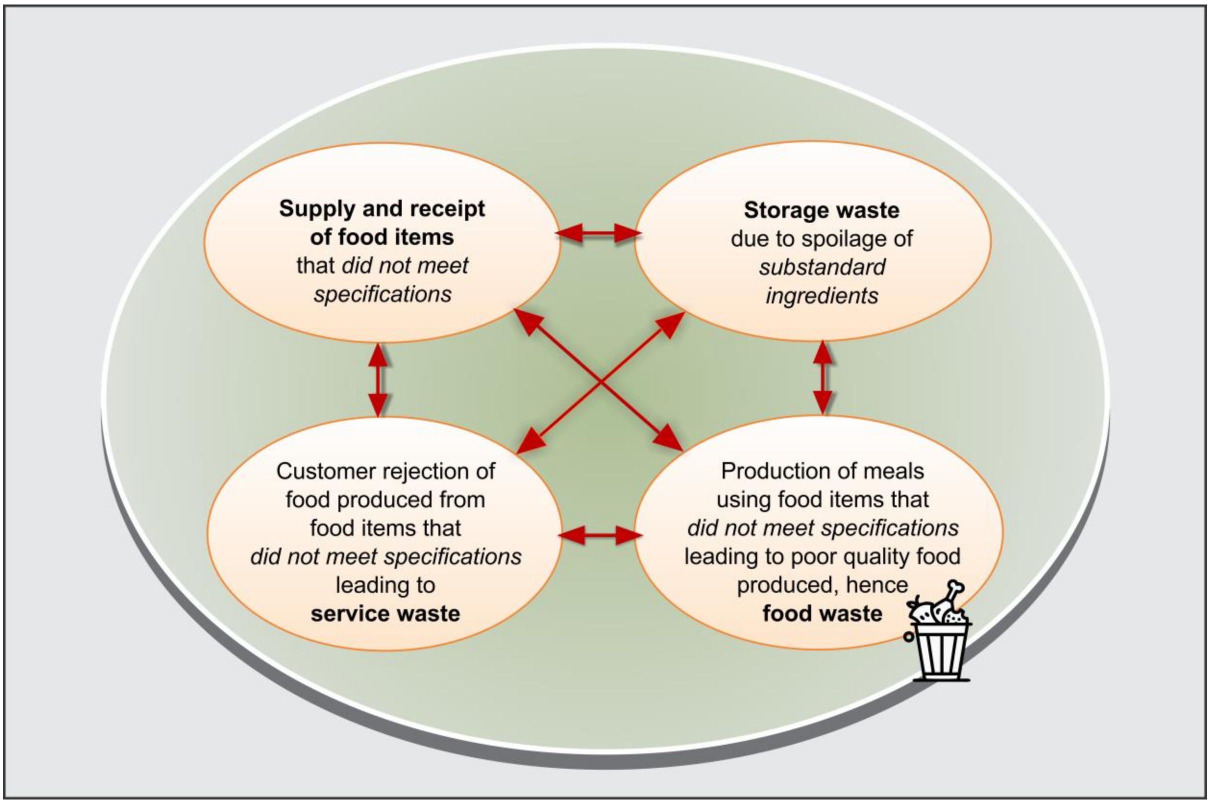


FIGURE 5.3: INTERDEPENDENCY OF SUBSYSTEMS AND THEIR CONTRIBUTION TO FOOD WASTE GENERATION

- *Attitudes of food service workers*

Attitudes of food service workers to food waste generation (or reduction) differed. Some food service workers were proactive and open about food waste, especially those at managerial level, as well as those at operational level with many years of work experience at the University food service unit, while others were not open to communication about practices leading to food waste generation (O, I). This was attributed to feelings of guilt and having a fear of possible disciplinary action by management as a result of generating food waste (I). According to one of the participants at management level:

> *"It is still difficult to control food waste because humans are scared that it's their fault, they made the mistakes and they don't feel nice about it".*

This resulted in failure to report food waste implying a lack of communication (*linking processes*) about food waste between some staff members and management, hence making it difficult in coming up with food waste prevention strategies.

It was observed that the feeling of fear attached to food waste generation made some food waste prevention mechanisms already in place to be ineffective (O). For instance, the University food service unit implemented a food waste recording tool to keep track and communicate the extent of food waste generation (O). Some food service workers did not record, and/or adjusted records on food waste generated at their stations. When asked why they did that, they revealed that they did not want to lose their jobs due to being wasteful (FG). In this way the memory element of the food service system was affected, as inaccurate records meant underestimating the level of food waste generated.

5.2.1.2 Raw materials

A number of factors related to food as raw materials in the food service system were considered as contributing to food waste and this included; packaging of ingredients, the amount used of preprepared ingredients and the quality of these. The next section elaborates on this.

- *Packaging influence on food waste*

Packaging was found to have an influence on the generation of food waste in two ways; inappropriate packaging size, and the difficulty to empty the food package. The findings showed that ingredients purchased in larger packages, due to the unavailability of smaller sizes, were sometimes leftover, and if not well managed, were wasted (O, I). Food items in the frozen form were wasted the most because of the unsuitably sized packages. This was because the frozen food items were defrosted as packaged and the remaining portion of ingredients was wasted, due to the restrictions on defrosting and freezing again for food safety reasons. One of the participants mentioned that:

> *"… if we have a package of 2.5 kg of beef cubes and we only need 2.2 kg, what happens to the 0.3 kg – it gets wasted".*

This was further demonstrated by the following comment:

> *"… products that are frozen in packets; stir fry, I mean you first have to thaw them [frozen food] before you can weigh them, then you freeze them and take them out again. You cannot freeze, thaw and refreeze. I saw one of the remarks on food waste records was that the meat in the package was more than the recipe required; so that resulted in waste".*

In agreement with this, a study conducted by Heikkilä *et al.* (2016), showed that where food products were not available in suitably small package sizes, the leftover ingredients were often not managed properly, or they were left on the shelf until expired, which created food waste.

Food wastage was also linked to packages that made it difficult to empty the contents (I). This is demonstrated in the comment below;

> *"I think we must go back to the producers and tell them it doesn't work. I mean if you have 20 kg of pumpkins and it's frozen in plastic bags, and you steam it in the plastic bags then you have to take it out into the container to be served and it is difficult making sure nothing is left in the plastic bag, it's really a concern'.*

In agreement with this, another participant indicated that:

> *"Like you weren't here last week we were talking about the pumpkin, that it's very hard to have to prepare it in the package and by the time you take it out of the oven, the package is very hot because it's plastic, so if you scrape out the food there is always a little left, that's waste. Whereas with freshly prepared ingredients,*

you cook it, you have your little wastage on skins and pips and stuff but you know whatever is left you can scrape it out of the pan so the wastage on that is so much lesser".

The viscosity of the food played an important role; food items with high viscosity were more inclined to stick to the inside of the packaging. The process of emptying the package was not only influenced by the packaging design but also by the method of food preparation. For instance, in the incidence cited above, it was difficult to remove the pumpkin from the package because it was prepared inside the package, making the plastic package too hot to handle and scrape off the food. Another important factor that could be attributed to the difficulty of emptying the contents, leading to food waste, included the absence of a fold or handle that could be used for easy handling when emptying the packages.

An important element that emerges from this discussion is the contribution of the supplier-food service operation interface (Figure 5.4) in causing food waste. The failure to design appropriately sized and easy to empty food packages led to food waste at the University food service unit.

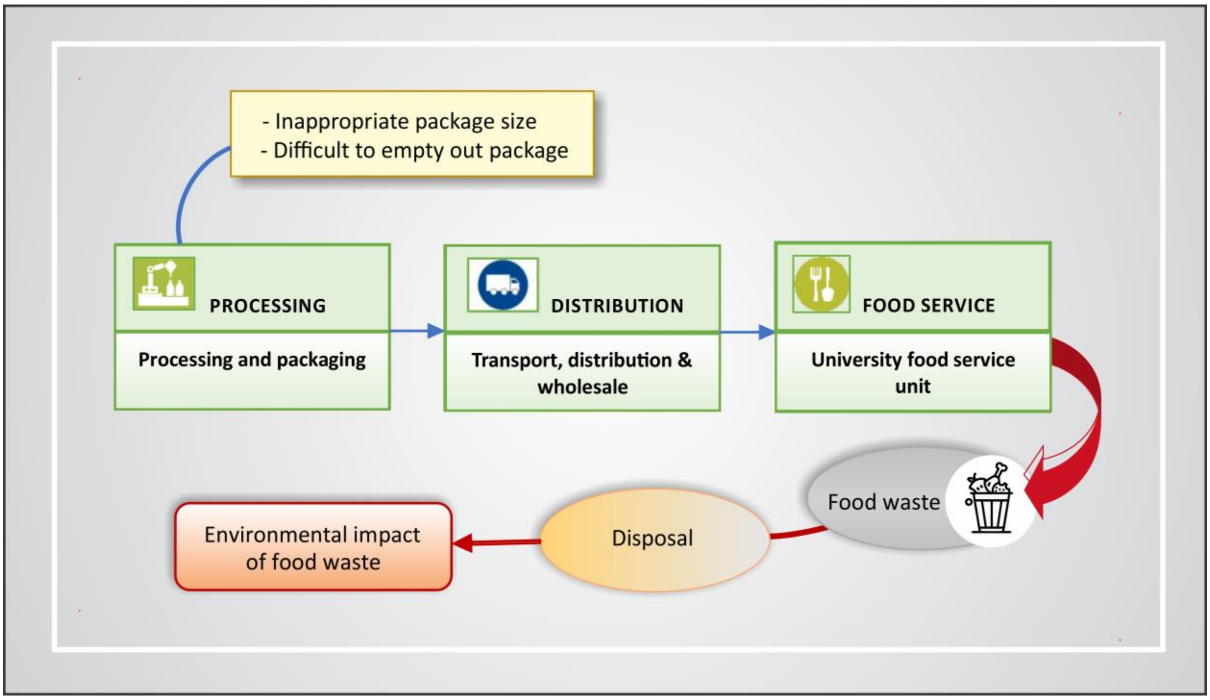


FIGURE 5.4: FOOD WASTE GENERATION AT THE SUPPLIER-FOOD SERVICE INTERFACE DUE TO PACKAGING

- *Preprepared ingredients*

The findings of the study further revealed that the extent to which ingredients were preprepared had an influence on the generation of food waste. It was indicated that the pre-cut and ready-to-eat food items purchased from suppliers contributed to food waste (I, D, O). The following comment from one of the participants illustrates the point:

> *"As from January until June, we have lost ZAR10 000.00 only at Tuks Monate as a result of the chuck size. So we now have to go back to the supplier and ask them to supply us with smaller cuts of chuck".*

The cuts of beef cited in the above statement were bought already pre-cut, and the pieces were larger in size than usual and fewer in quantity or number of portions (I, O). This led to waste in terms of monetary value. This indicates a different dimension of food waste in the food service system. Although most of the studies measure food waste by mass, this example indicated the financial implications of food waste.

Notwithstanding the above findings, the study further indicated that with certain food items, preprepared ingredients generated less waste compared to wholesome, unprocessed ingredients. This is illustrated in the comment below:

> *"We had wastage of the outer leaves of the lettuce, when we used to prepare the salads from whole heads of lettuce, so we stopped ordering it, it was after the waste was so high that we went back to the vacuum packaged lettuce and that was fine".*

These findings are in accordance with findings reported by McAdams, von Massow, Gallant, M and Hayhoe (2019), who indicated that a restaurant making salad, using whole heads of romaine lettuce, generated more food waste from the blemished outer leaves and the stems, which were removed and discarded as preparation waste. McAdams *et al.* (2019) further indicated that the same lettuce served in a similar salad at other establishments was supplied pre-cut and washed, ready to use directly from the bag and thus generated less or no waste. The extent to which certain ingredients generate food waste as preprepared versus whole food products, is thus a considerable factor in the generation of food waste in food service units.

With regards to food items bought ready-to-eat, it was observed that ready-to-eat sandwiches generated more food waste compared to freshly prepared sandwiches produced at the food service unit (O). This was due to having greater flexibility by controlling the right quantity of sandwiches prepared in-house, whereas controlling quantities of ready-to-eat sandwiches, bought from suppliers was difficult as orders were made in advance. This is contrary to previous studies (Papargyropoulou *et al*., 2016; Pirani & Arafat, 2014), which indicated that preprepared ingredients or food items, generated less waste than minimally processed ingredients or food items. This difference may be attributed to the point at which waste was generated. While the use of preprepared or processed food products significantly reduced food waste at production stage, it was not the case with food waste at storage and service functional subsystems. Production waste was reduced, as little or no preparation and production meant no waste arising from such tasks as trimming, peeling, and others. Storage waste occurred in cases where food was not bought and received well ahead of the expiry date, and service waste was created where customers rejected the preprepared food items, due to perceptions of poor quality, compared to freshly prepared food items. In addition to this, the use of preprepared ingredients shifted food waste up the food supply chain. For sustainability, there is therefore, a need to have a shared responsibility towards food waste reduction throughout the interlinking stages of the food supply chain. Such a synergistic relationship between the various stages of the food supply chain has potential in addressing food waste holistically.

- *Quality of ingredients*

The procurement and use of poor quality or substandard ingredients contributed to food waste in the University food service system (FG, I). Heikkilä *et al*. (2016) briefly mentioned that the quality of the ingredients used, affects kitchen waste and plate waste, but did not give a detailed explanation of how they contributed to wastage. The influence of the quality of ingredients in food waste generation was demonstrated by comments made by participants of the focus group discussion and face-to-face interviews below:

> *"Food waste is caused by poor quality ingredients that were received".*
>
> *"… there are herbs and spices that we have to order because they are less expensive but they are poor quality. It's like the baking powder as well, we really had a problem with baking powder because its quality is poor. We threw away,*

I don't know actually how many pans of cake, because of baking with a certain brand of baking powder".

The quality of the ingredients contributed to food waste generated at the different stages of the functional subsystem; storage, production and service points. For example, poor quality ingredients that were received at the food service unit, caused food waste during storage, due to spoilage before the food item could be used (O, I). Additionally, poor quality ingredients caused food waste during production as the use of such ingredients often resulted in recipes failing, for example, the baking powder cited in the narration above, resulted in poor quality baked products, which ended up being discarded (I). In some instances, menu items produced from poor quality ingredients were rejected by consumers at the service point, which led to service waste (FG). These findings illustrate that parts of the food service system interact with one another and are interdependent, with inputs (quality of ingredients) influencing food waste in other parts of the system.

5.2.1.3 Facilities

The findings further revealed that the unavailability of suitable equipment had an influence on food waste generation. This is discussed in the next subsection.

- *Equipment*

The unavailability of appropriate equipment at different stages (production and service) of the food service system contributed to food waste. The participants highlighted that the food service unit lacked appropriate baking and serving equipment (FG, I).

"What also happens on the waste side is that some of the pans have sloping sides and this results in smaller portions from the sloped sides instead of having appropriately sized portions. Such portions cannot be served to customers. The same happens with the baked desserts; if you have a baked dessert and the chef doesn't use a straight pan, then you can have it (a dessert) that is not well shaped and end up losing portions that are too small. The other thing that can add to waste is that we do not have a cutting frame so it is human error to divide the pan into uneven portions and we end up wasting portions that are too small to serve".

Similar observations were made during participant observations; portions that were too small or not well cut (e.g. beef lasagna) due to the lack of appropriate equipment, were wasted since such portions were not adequate enough to be served to customers (O). In support of the findings, Heikkilä *et al*. (2016) found that the lack of suitable equipment affects food waste. The unavailability of appropriate equipment, such as a portioning frame for desserts, affected other parts of the food service system. For example, even though the food service operation had set standardised portion controls, the unavailability of the appropriate equipment resulted in incorrect portioning of some menu items, which led to food waste generation.

5.2.1.4 Operational resources

Under operational resources, time was identified as a contributing factor to food waste generation.

- *Operating time*

Operating times, specifically the time at which the food service unit closed at each end of a meal service, were perceived by most participants as a constraint linked to food waste generation. The dining hall times are tabulated below (Table 5.2).

TABLE 5.2: DINING HALL OPERATING TIMES

	MONDAY - FRIDAY	SATURDAYS	SUNDAYS AND PUBLIC HOLIDAYS
BREAKFAST	06:30 – 08:00 Booked meals only	No breakfast provision	No breakfast provision
LUNCH	11:00 – 14:00 Combos	11:30 – 1300 Booked meals only	11:30 – 1300 Booked meals only
SUPPER	16:30 – 18:30 Booked meals only	16:00 – 1800 Combos	16:00 – 1800 Combos

Food service workers commented that the operating times for the food service unit, especially for lunch and supper, were a constraint when the students were too busy as there would be limited time to walk from the Hatfield main campus to the food service unit in Hillcrest (FG). Additionally, walking to the food service unit became a substantial constraint when students had lectures close to lunch times or late in the evening, close to supper times. Such factors led to booked meals not being taken, or a lesser number of students buying meals than were anticipated. These findings are in accordance with findings reported by Painter *et al*. (2016), who established that students at Rhodes University missed meal services at the University catering facilities, due to time constraints, which resulted in food waste generation.

The study further found that strict adherence to closing times without consideration of the food remaining after service, led to food waste (FG, O). This is illustrated in the comment below:

> *"… sometimes we do have waste like chips, if we produce more chips that students end up not buying as lunch time elapses, we waste because with chips we can't reheat and re-sell them".*

As highlighted in the statement above, not all leftover food items could be kept for later use. In accordance with quality standards and food safety regulations unserved food items, such as chips, and reheated meals could not be kept for later use and thus were discarded at closing times. This implies that inputs (time) and controls have a reciprocal relationship and affect the performance of each other. Past research (Burton *et al*., 2016; Prescott *et al*., 2019) mentioned that closing times have an influence on food waste generation but failed to explain this observation in detail.

In summary, food waste as a result of the inputs of the food service system, can be represented in the framework below (Figure 5.5).

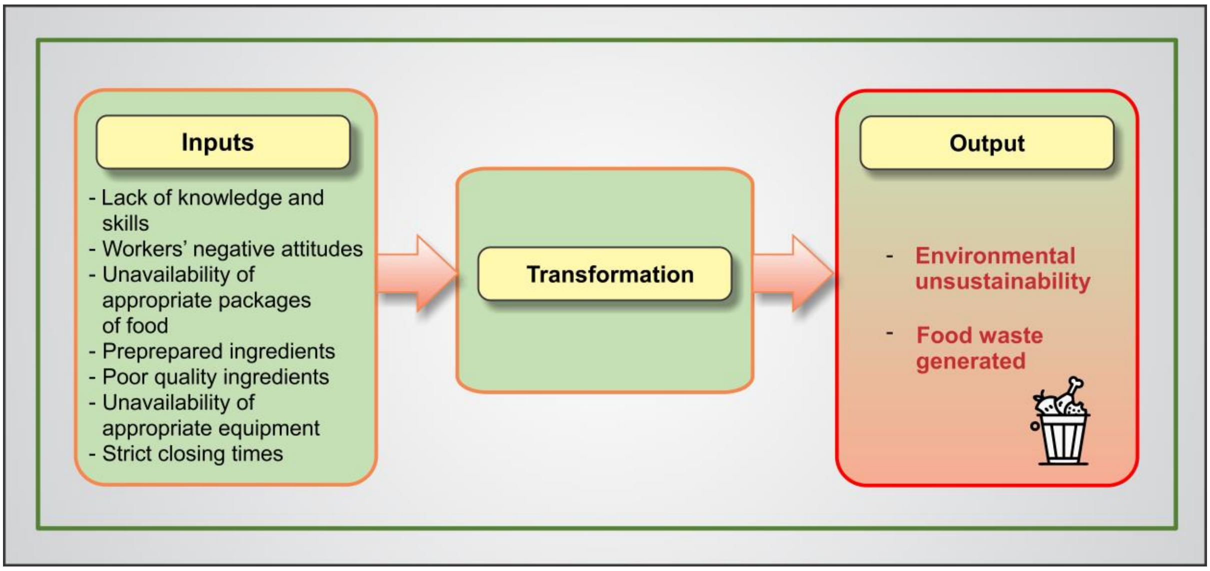


FIGURE 5.5: IDENTIFIED CAUSES OF FOOD WASTE AS A RESULT OF THE INPUTS OF THE UNIVERSITY FOOD SERVICE UNIT

5.2.2 Transformation

The following subsections focus on the causes of food waste in the transformation process of the food service system, including the functional subsystems of the food service operation, management functions, and linking processes.

5.2.2.1 Functional subsystems

This section discusses the causes of food waste in the functional subsystems of the University food service system, from procurement to service.

- *Procurement*

Several practices during procurement contributed to food wastage. During the interviews, participants highlighted that procurement of unpopular food items caused food waste (I). This is a similar finding to the previous research conducted by Charlebois *et al.* (2015), who mentioned that expansive inventories with unpopular food items that were not consumed before expiry, resulted in food waste. In this study, unpopular items, such as *Halaal* foods, were often not consumed before the expiry date, causing storage waste.

> *"… we used to order the Halaal foods and it wasn't very popular. It ended up not being consumed and resulted in waste".*

The comment above suggested that even though there are food waste prevention strategies at the University food service unit regarding expired food items, such strategies did not always work with unpopular food items. Examples of food waste strategies, include stock monitoring and stock movement control, as well as flexible menu planning.

Overstocking was also identified as a contributing factor of food waste generation, though to a lesser extent (O). For example, during the study period, such items as peppermint crisps, pecan nuts, caramel treats, brisket rolls, knotted rolls and vegetable style strips were overstocked and some reached the expiry date before use (D). Contrary to previous studies (Martin-Rios *et al*., 2018; Thyberg & Tonjes, 2016), food waste generated as a result of overstocking was generally low at the case University food service unit. This may be attributed to the multiple stock control measures put in place, such as the use of the RCL system (a computerised stock management system), stock monitoring through recording stock movement, as well as recording inactive food items. These measures are discussed in detail in Chapter 6. Notwithstanding this, it was observed that when overstocked ingredients were about to expire, the production unit was informed and planned the menu around such ingredients (O). Even though this prevented food waste at the storage point, sometimes it created food waste at the production and service points as a result of overproduction of food that was reaching the expiry date (O, I). Additionally, as discussed under the inputs (Section 5.2.1.2), purchasing poor quality food supplies contributed to food waste.

- *Receiving*

Failure to check quality against specifications and to identify poor quality, damaged or spoiled food products at the time of delivery, led to receiving food that ended up being discarded instead of rejected and returned to the supplier (I, O). This was mostly the case with fresh produce, including fruit and vegetables. Charlebois *et al*. (2015) in their study to identify key determinants of food waste in food service outlets, reported a similar issue that if receivers failed to identify poor quality at the time of delivery the food service outlet ended up taking the waste instead of returning the food supplies to the suppliers.

The following quotation indicates the cause of food waste at the receiving point:

> *"… there are specifications but I think at the point of receiving the specifications are not always followed or checked".*

This shows that the availability of quality controls, such as food specifications alone is not enough to reduce food waste, but correct interpretation and strict adherence to specifications is important in reducing food waste. It was further observed that some perishable food items received were not immediately transferred to the storage areas (O). For example, it was observed that frozen packets of mixed vegetables that were delivered, were not immediately transferred to the cold storage area. Even though food wastage was not immediately observed as a result of this, mishandling food products during the receiving process, may lead to food spoilage and ultimately food wastage in subsequent stages of the functional subsystem (Charlebois *et al*., 2015).

- *Storage, inventory control and issuing*

The major issue that emerged during the study was the improper storage of food supplies, which led to food deterioration, resulting in food waste during storage (O, FG). Similarly, previous studies (Betz *et al*., 2015; Engström & Carlsson-Kanyama, 2004; Filimonau & De

Coteau, 2019; Thyberg & Tonjes, 2016) indicated that food items which were not stored properly, spoiled leading to food waste. The participants pointed out the tendency to overproduce food, which was sometimes stored for a longer time than appropriate, resulted in spoilage, hence food waste generation (FG). It was also observed that some leftover foods were stored uncovered and exposed to extremes of temperature, hence spoilage (O). For example, a bowl of prepared salad was left uncovered, which led to quality deterioration, including colour changes and wilting, hence food waste generation (Figure 5.6). According to Manzocco, Alongi, Lagazio, Sillani and Nicoli (2017:132) these changes may be attributed to “storage conditions promoting a decrease in the green index, which can be attributed to chlorophyll degradation upon the metabolic stress induced by cut operations, and an increase in the brown index due to phenol oxidation”.

FIGURE 5.6: DISPOSED LEFTOVER SALAD THAT WAS STORED UNCOVERED

In another instance, 11 litres of custard cream, which was prepared in advance, was held in the freezer for an unrecorded period of time. At a time when the food service unit intended to serve the custard cream, syneresis had occurred; which is the expulsion of liquids from a starch product (Figure 5.7). Additionally, the quality of the custard cream consistency and colour deteriorated, as a result was disposed of (Figure 5.8). Other food items, such as steamed pudding, were also negatively affected by cold storage, deteriorated in quality and were discarded (Figure 5.9).

FIGURE 5.7: SYNERESIS OF CUSTARD CREAM

FIGURE 5.8: DISPOSED CUSTARD CREAM

FIGURE 5.9: DISPOSED STEAMED PUDDING

Still at the storage stage, some participants highlighted failure to store food at the correct refrigerator and freezer temperatures as a possible driver to food waste (FG, I). Failure to keep food at the correct temperatures led to spoilage of food, making it unsafe for consumption. This was a rare but high impact issue that resulted in a considerable amount of food waste (I). It was commented that:

"… we had such a high waste when the meat was kept in the fridge at an incorrect temperature for two days, so that's when we lost 18 pans of beef stew".

Food waste generation, due to incorrect refrigerator or freezer temperature in food service operations, has not been indicated as a problem in previous literature. The literature frequently cites maintaining the refrigerator at too high a temperature being a major concern, causing food waste at household level (Brown, Hipps, Easteal, Parry & Evans, 2014; Van Geffen, Van Herpen & Van Trijp, 2020; Van Holsteijn & Kemna, 2018). In this study, this was an unusual occurrence, given that the University food service unit implemented a food safety programme (*control*) that required regular monitoring and recording of the refrigerator and freezer temperatures. A possible explanation for the incorrect temperature of cold storage could be mechanical failure of the refrigerators and freezers. It is therefore, important to ensure regular maintenance of such equipment.

Moreover, some participants indicated that failure to follow inventory and stock rotation methods, such as FIFO (First-in, First-out) led to the use of food products without consideration of production dates and expiry dates (FG). During the observation, the storekeepers pointed out that during instances when they were not available for issuing, cooks or chefs often took out ingredients without following the FIFO approach, which contributed to food waste (O). Ingredients were returned to storage areas without consideration of inventory management methods, such that stock was used randomly, hence older stock being wasted. The same challenge was faced with issuing of cook-chilled or cook-frozen menu items as narrated by one of the participants below (FG, O):

"… we do experience food waste like today we have wastage of cooked rice. You know what they do; they keep food for too long instead of using the first in, first out principle".

This mostly happened with cooked food that was produced in bulk. In this case, freshly produced food ended up being served first and older stock being wasted. This finding is in agreement with that of Charlebois *et al*. (2015), Filimonau and De Coteau (2019) and Halloran *et al*. (2014), who stated that failure of staff to adhere to stock rotation principles, such as FIFO, contributed to food waste.

Furthermore, failure to date mark food during storage was identified as a reason for food waste. The researcher observed that some food items produced at the University food service unit were stored without date labelling (Figure 5.10). This made it difficult for food service workers to make decisions on which food products to use at a certain time, which led to the deterioration of older stock and hence waste. While poor stock management has been broadly cited as a cause of food waste in food service operations, failure to date mark food during storage has not been previously cited in past literature.

FIGURE 5.10: CUSTARD SAUCE STORED WITHOUT DATE LABELLING

Failure to control pests in the storage areas was cited as one of the causes of food waste in the food service system (I). Supporting this observation, it was noted:

> *"… we had a rat and the destruction that the rat caused was incredible, that flour, oh it was disastrous".*

Along the same lines, failure to strictly adhere to food storage requirements was found as a culprit in attracting pests and insects (I). In support of this, one of the participants commented that:

> *"… I think in some way the policy of removing stock from boxes is not applied 100% because some products are still stored in boxes like macaroni".*

The issue of pests as a cause of food waste has not been previously cited in the food service literature. Rather, pests have been frequently mentioned as a cause of food loss in the primary agricultural production stage of the food supply chain (Priefer *et al*., 2016). In this study, participants highlighted rats and cockroaches as the most prevalent pests and insects found in the food service unit (I). These pests and insects contaminated food items with their droppings and possible bodily secretions. They also consumed some food items. Rats damaged food containers and packaging, leading to spillages and allowing for contamination, hence food wastage (I). However, this was not a common problem at the case University food service unit as pest control and fumigation were performed on a regular basis.

Failure to weigh food during the process of issuing was identified as a contributing factor to food waste (I). This led to the failure to track food waste nor account for it. In relation to this, participants noted that:

> *"Yesterday I explained to one of the workers that he has to weigh what the stock clerks are giving him, although its 23 kg of steak, weigh it and check, because I explained to him if they give him 23 kg of steak, the rest of his calculations must also add up to 23 kg so yesterday we were short of 280 grams, so I told him remember that amounts to a wastage of two steaks, because a steak is 150 grams".*

Additionally, failure to accurately measure ingredients when issuing, contributed to food waste (O). For instance, as illustrated in Figure 5.11, more bread flour than the recipe required was issued and the flour that remained after preparation was discarded instead of returning it to storage (O). Inaccuracy in the measurement of ingredients also led to the production of poor-quality menu items that were discarded as production or service waste (O). The standard procedure set by the University food service unit was that food had to be measured by the store keeper when issuing, and by the chef or cook when receiving but this was not always practiced, which led to difficulties in tracking food waste. Food waste as a result of these factors has not been documented in previous literature.

FIGURE 5.11: BREAD FLOUR WASTED AS A RESULT OF INCORRECT MEASURING

- *Production*

The findings of the study indicated that overproduction was one of the leading causes of food waste in the University food service system (D, O, FG, I). The themes that emerged from the study regarding food waste caused by overproduction of food, informed the development of the food waste framework presented in Figure 5.12. In cases where food was overproduced, leftovers remained at the service point. From the leftovers, food suitable for later use was stored; that which was not suitable for later use, such as reheated leftovers, were discarded leading to service waste. Of the surplus food stored, some lost quality and/or was spoiled, which resulted in storage waste, which is the least favourable food waste management option. Leftovers, which were of a good quality, were sold, thus preventing food waste. As indicated in this discussion, overproduction led to food waste at the service and storage points, which demonstrated the interdependency nature of the food service system.

A common view amongst participants was that overproduction was a result of inaccurate forecasting (O, FG, I). This finding was also reported by Goonan *et al.* (2014). Challenges of the forecasting system that exacerbated the overproduction problem, included the booking system that allowed students to cancel bookings a few hours before production when preparation was already completed. Another possible explanation for overproduction of food

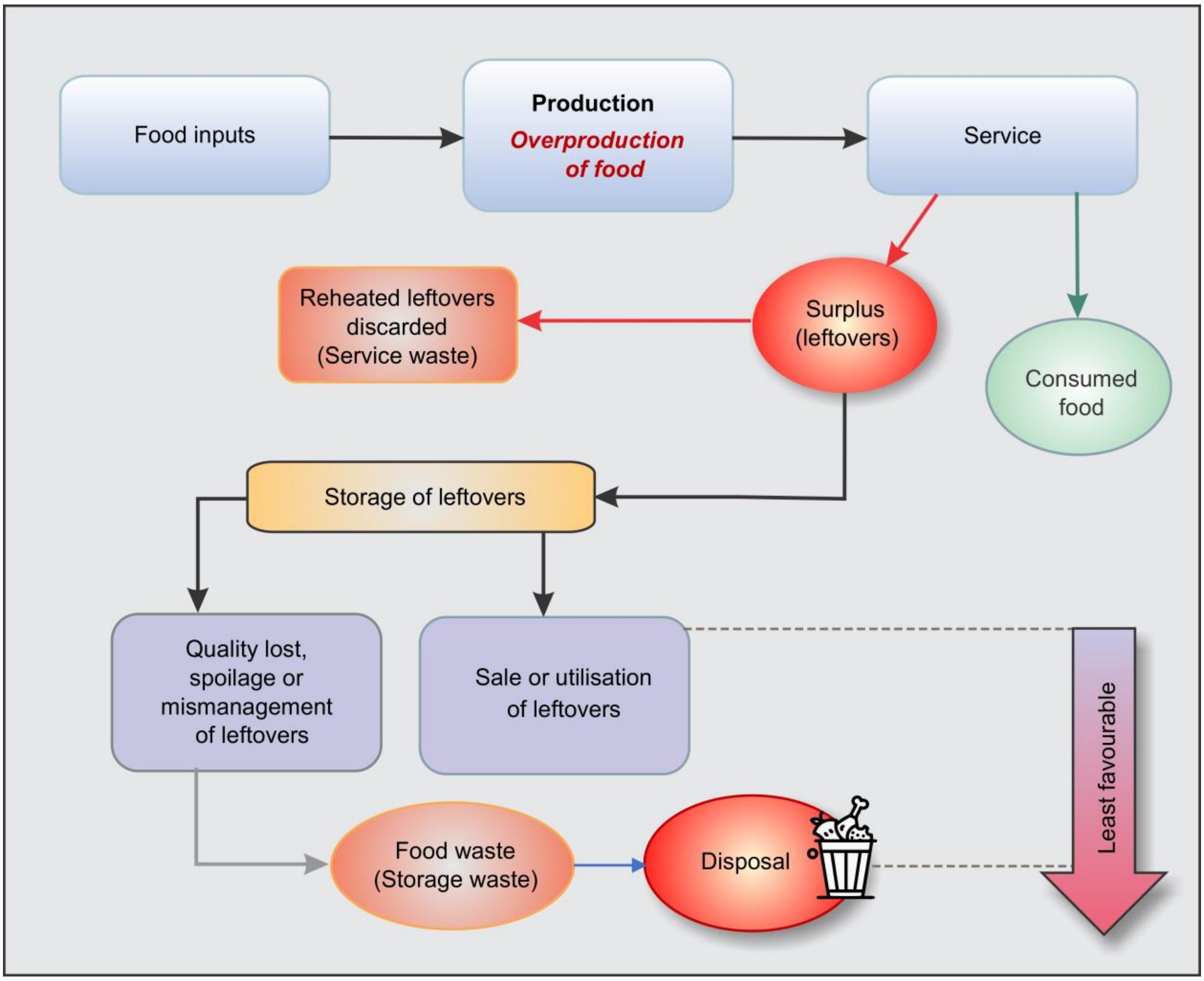


FIGURE 5.12: OVERPRODUCTION AND FOOD WASTE FRAMEWORK

might be that less consideration was given to the quantities for the less costly dishes, such as starchy food and vegetables. Historical records, such as past customer counts, meal statistics, or sales records that could be used as the basis for forecasting, were not always applied when planning for the production of starchy foods. As such, it was observed that pans of starchy foods, such as rice and maize meal porridge, (Figure 5.13) were discarded in large quantities.

The following comments illustrate the intensity of the problem of overproduction:

> *"The other thing that has a lot of waste is maize-meal porridge. Porridge ...eish… (whistling). We throw a lot of porridge into rubbish bins. For example; they (chefs or cooks) cooked porridge for staff meals like over the weekend, they did not eat that porridge leaving [two-three] (2-3) pans of porridge, additionally, they cooked about [six} (6) more pans of porridge for students for supper, about [four]*

FIGURE 5.13: LEFTOVER MAIZE MEAL PORRIDGE DUE TO OVERPRODUCTION

(4) of them remained, we discarded a lot of porridge last week so much that my heart hurt as if the maize meal was mine".

Another participant commented:

> *"Yesterday production workers cooked [eight t0 ten] (8 - 10) pans of rice in the morning and put them for holding in the heated cabinets, some rice was eaten at lunch and a lot of pans were still left. At supper (booked) it was rice again and potatoes, the production staff cooked more rice and put it in the heated cabinets. The students ate potatoes because they prefer potatoes, the potatoes got finished and rice was leftover, we took back about [seven to ten] (7-10) pans of rice".*

This suggests that overproduction of food can be attributed to the failure to consider the number of meals produced or leftovers, prior to producing more of that menu item. Additionally, students' preferences were overlooked when estimating the quantities of menu items to be prepared. As indicated in the previous comment, students preferred potatoes over rice. However, more rice than needed was produced resulting in approximately seven to ten (7-10) pans of leftover rice. This implies that food waste resulted where menus were planned without considering students' preferences and needs. A similar finding was reported by Marais *et al*. (2017) who indicated that students attributed food waste at Stellenbosch University to failure of the catering facility to consider their preferences of food items and meal sizes. However, food service workers at Stellenbosch University reported that menus were planned based on the preferences and needs of the students.

Other participants indicated that when food was overproduced, leftovers were stored for later use but after a certain period of time certain food items lost quality and had to be discarded (for example, creamed broccoli and gravy in Figure 5.14) (FG, O). Talking about this issue, a participant said:

> *"… what happens is that there could be food prepared and then it was not served in time, within 3 or 4 days then we have to throw it out. We can't serve that".*

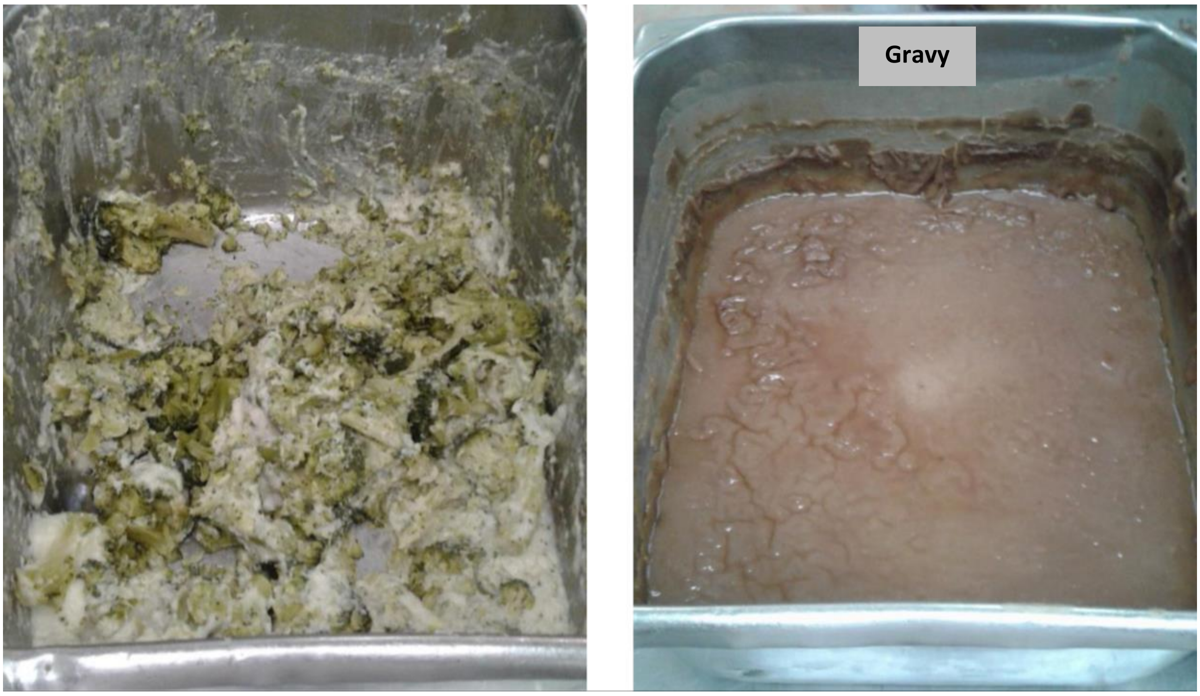


FIGURE 5.14: LEFTOVER CREAMED BROCCOLI AND GRAVY DUE TO OVERPRODUCTION

From the participant's observations it was noted that 12 portions of maize meal porridge, ¼ pan of creamed broccoli and ½ pan of beef gravy were discarded in just a day (Figure 5.15). Additionally, two pans of spaghetti were disposed of (Figure 5.16).

FIGURE 5.15: DISPOSAL OF OVERPRODUCED PORRIDGE, CREAMED BROCCOLI, AND GRAVY

FIGURE 5.16: OVERPRODUCED SPAGHETTI (PASTA) DISCARDED

In corroboration with the findings from the interviews and observations, analysis of the documents indicated that indeed there was food wastage as a result of overproduction. Table 5.3 (next page) shows a record of meal statistics from the 25th to the 31st of July 2016 and the food waste generated from these. The bulk of the wastage tabulated below resulted from over-produced food. Leftovers, which were stored and reheated for service but were not consumed at this point, were discarded as they could not be reheated twice for safety reasons. It is apparent from Table 5.3 below that the chicken patty, chicken al Forno and Portuguese chicken were the most wasted dishes (100% wastage). A possible explanation for the wastage might be that the most wasted food items are at their best quality when freshly prepared rather than reheated. Some food items, such as fried eggs, were least wasted as they were utilised in the production of sandwiches.

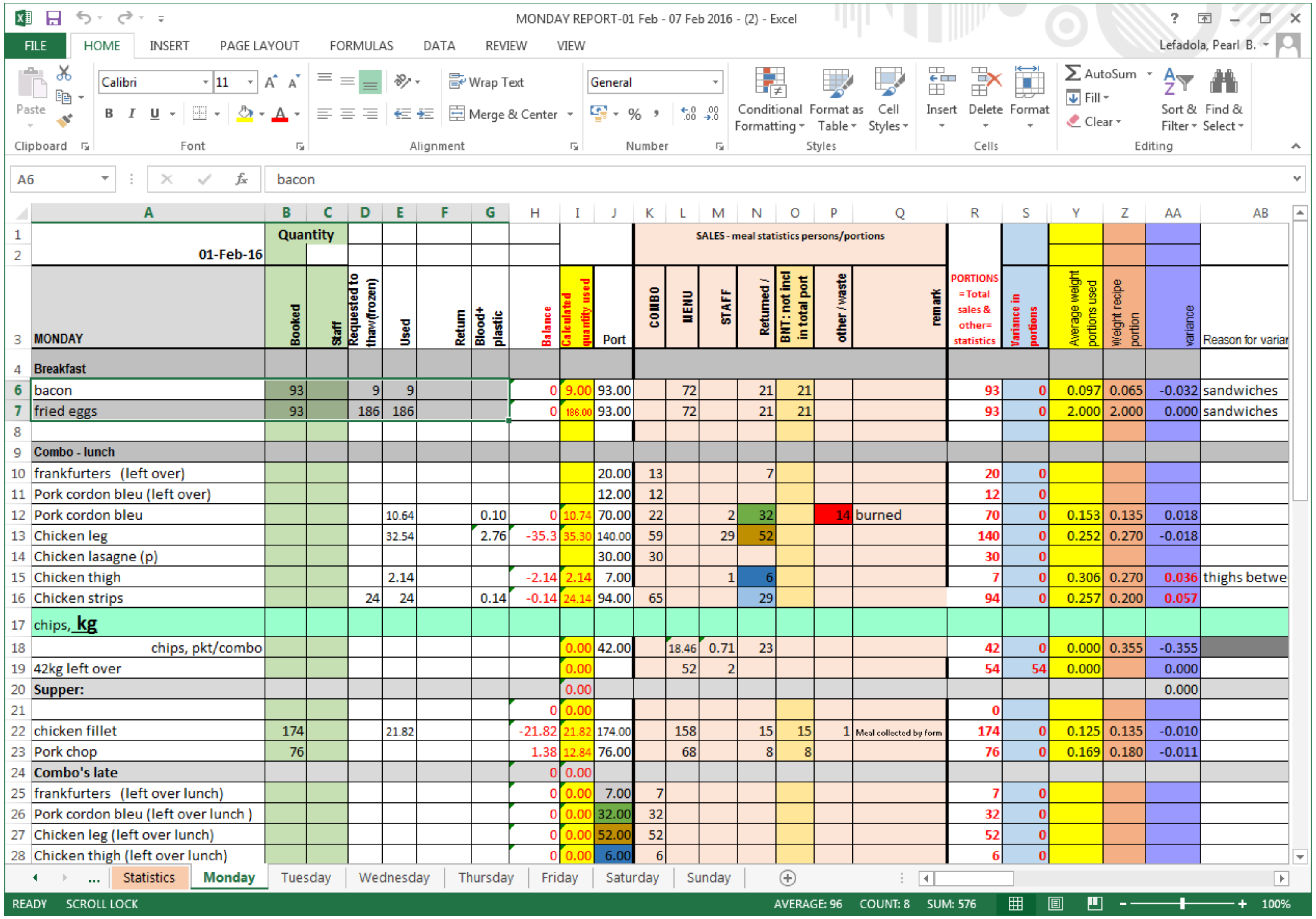
TABLE 5.3: MEAL STATISTICS AND FOOD WASTE FROM THE 25th – 31ST JULY 2016

Food items	Meal statistics (portions)	Sold	Waste
Pork chops	51	51	0
Battered hake fillet	43	41	2
Bolognaise mince	42	42	0
Brisket roll	15	12	3
Chicken leg (supreme)	14	14	0
Beef goulash	14	9	5
Beef steak	8	7	1
Chicken fillet	7	6	1
Chicken schnitzel	5	4	1
Fried eggs	3	3	0
Chicken patty	3	0	3
Chicken al Forno	3	0	3
Portuguese chicken	1	0	1

Comparing the findings with those of other studies, confirms that overproduction of food is the leading cause of food waste in food service units (Burton *et al*., 2016; Goonan *et al*., 2014; Heikkilä *et al*., 2016; Kasavan *et al*., 2019; Prescott *et al*., 2019). In accordance with the present findings, previous studies have demonstrated that overproduction resulted from inaccurate forecasting (Garrone, Melacini & Perego, 2014; Goonan *et al*., 2014; Silvennoinen *et al*., 2015).

However, some studies (Prescott *et al*., 2019) presented the underlying causes of overproduction that were not observed in this study. For example, previous studies linked the buffet service to overproduction. This was not observed in the current study as the researcher did not observe the buffet services offered during the time of data collection. Additionally, Prescott *et al.* (2019) showed that overproduction in their study was caused by making extra food for all the entrées to make allowances for students to change their choice of meals. In this study, there was no provision for a change of choice of entrees for the booked meals, which prevented wastage.

Food production mistakes, such as burning and overcooking of food items, as a result of improper temperature control and failure to adhere to the prescribed cooking times, also influenced production waste (I, D, O, FG). As illustrated in Figure 5.17, food waste records for the week beginning 1st of February 2016, indicated that 14 of the 70 portions (20%) of pork cordon bleu were wasted as a result of burning (D).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Y	Z	AA	AB
1		Quantity									SALES - meal statistics persons/portions												
2	01-Feb-16																						
3	MONDAY	Booked	Staff	Requested to thaw(frozen)	Used	Return	Blood+ plastic	Balance	Calculated quantity used	Port	COMBO	MENU	STAFF	Returned /	BNT: not incl in total port	other / waste	remark	PORTIONS =Total sales & other= statistics	Variance in portions	Average weight portions used	Weight recipe portion	variance	Reason for variar
4	Breakfast																						
6	bacon	93		9	9			0	9.00	93.00		72		21	21			93	0	0.097	0.065	-0.032	sandwiches
7	fried eggs	93		186	186			0	186.00	93.00		72		21	21			93	0	2.000	2.000	0.000	sandwiches
8																							
9	Combo - lunch																						
10	frankfurters (left over)									20.00	13			7				20	0				
11	Pork cordon bleu (left over)									12.00	12							12	0				
12	Pork cordon bleu				10.64		0.10	0	10.74	70.00	22		2	32		14	burned	70	0	0.153	0.135	0.018	
13	Chicken leg				32.54		2.76	-35.3	35.30	140.00	59		29	52				140	0	0.252	0.270	-0.018	
14	Chicken lasagne (p)									30.00	30							30	0				
15	Chicken thigh				2.14			-2.14	2.14	7.00			1	6				7	0	0.306	0.270	0.036	thighs betwe
16	Chicken strips			24	24		0.14	-0.14	24.14	94.00	65			29				94	0	0.257	0.200	0.057	
17	chips, kg																						
18	chips, pkt/combo								0.00	42.00		18.46	0.71	23				42	0	0.000	0.355	-0.355	
19	42kg left over								0.00			52	2					54	54	0.000		0.000	
20	Supper:								0.00													0.000	
21								0	0.00									0					
22	chicken fillet	174			21.82			-21.82	21.82	174.00		158		15	15	1	Meal collected by form	174	0	0.125	0.135	-0.010	
23	Pork chop	76						1.38	12.84	76.00		68		8	8			76	0	0.169	0.180	-0.011	
24	Combo's late							0	0.00														
25	frankfurters (left over lunch)							0	0.00	7.00	7							7	0				
26	Pork cordon bleu (left over lunch)							0	0.00	32.00	32							32	0				
27	Chicken leg (left over lunch)							0	0.00	52.00	52							52	0				
28	Chicken thigh (left over lunch)							0	0.00	6.00	6							6	0				

FIGURE 5.17: FOOD WASTE TRAIL RECORDED FROM 1ST– 7TH FEBRUARY 2016

On some occasions, food waste due to burning of food was also observed (I, O, FG). For example, it was observed that pumpkin fritters, which were burnt (Figure 5.18) were disposed of (O).

FIGURE 5.18: BURNT PUMPKIN FRITTERS

The participants, on the whole, demonstrated that burning or overcooking of food contributed to food waste generated at the University food service unit as echoed in the comments below:

> *"Vegetables also have a lot of waste. The problem is that they change colour, if they are green, they turn brownish, vegetables like broccoli and mixed vegetables change colour a lot. We face waste when such vegetables are cooked for too long".*

> *"… like the product gets burned, maybe when somebody forgets it in the oven or the product dries out, that's the waste that I experience in production".*

Previous literature failed to clearly discuss burnt or overcooked food as a contributor to food waste. Charlebois *et al*. (2015) merely listed burnt food items as a factor in food waste but did not discuss this aspect in depth.

The study further demonstrated that the causes of food waste were dependent on the food production system applied by the food service unit. The case University food service unit applied a combination of food production systems; conventional, ready prepared and commissary food service systems. These different food production systems were described in Chapter 3, Section 3.2.4. Figure 5.19 below indicates points at which food waste was generated in the food production system of the University food service unit.

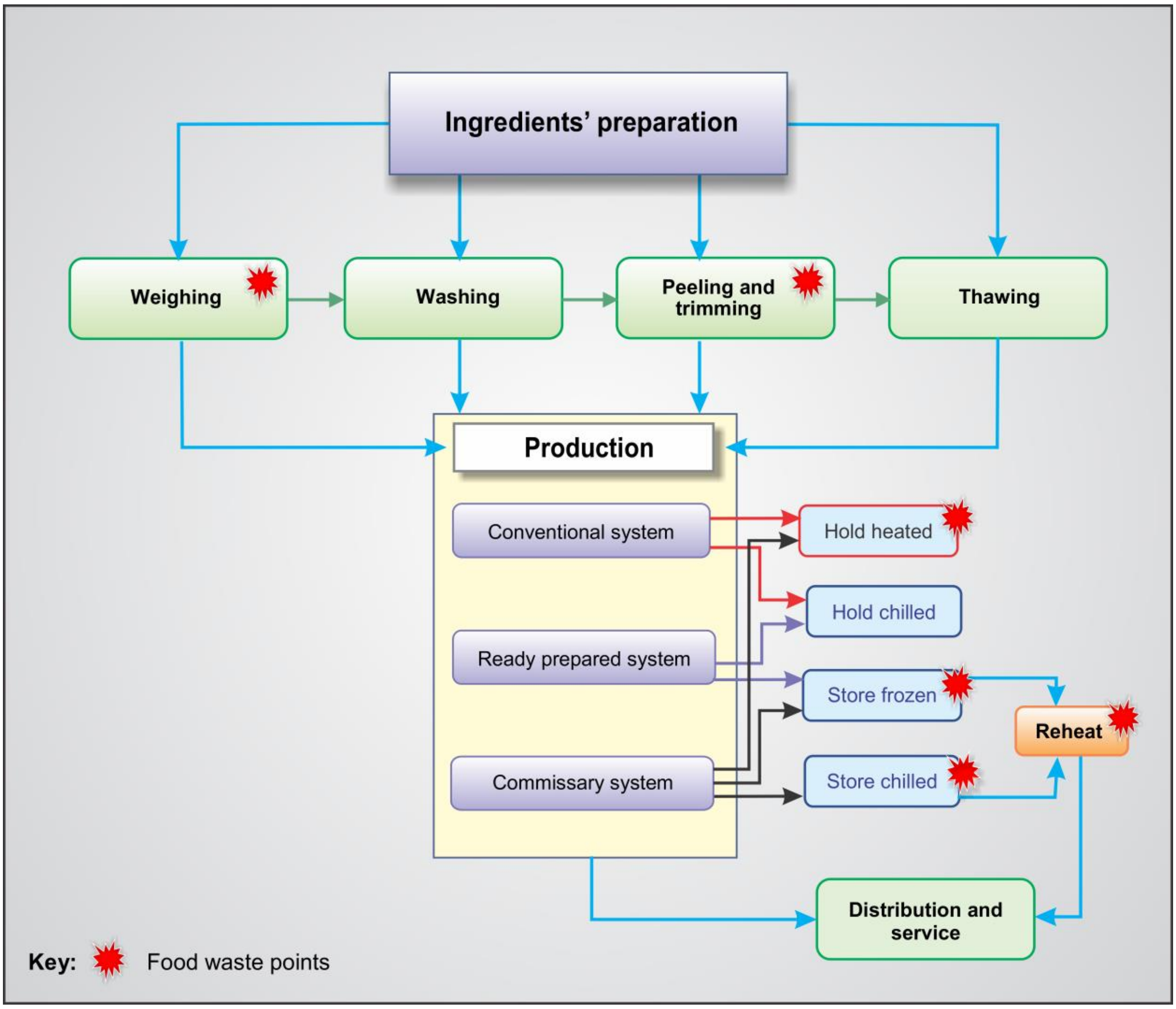


FIGURE 5.19: POINTS OF FOOD WASTE GENERATION IN THE FOOD PRODUCTION SYSTEM

Incorrect measuring or weighing of ingredients contributed to food waste (O, FG). This involved weighing more ingredients than needed, which ended up being discarded instead of being returned to storage. In some cases, the inaccurate measuring of ingredients led to the production of poor-quality menu items, which resulted in service waste. During the preparation of food, the ingredients (*inputs*), which were less processed and required peeling, trimming and cutting, contributed to unavoidable food waste (O). This is supported by the findings of other studies (Papargyropoulou *et al*., 2016; Pirani & Arafat, 2014), which linked minimally processed ingredients requiring preparation and cooking from scratch, with food waste generation at the preparation and production level. Additionally, cutting more ingredients than required, which were not stored for later use, led to food waste (O). As illustrated in Figure 5.20, excess green peppers were cut, and then were thrown away, contributing to food waste. However, this finding has not previously been described. A possible explanation for this might be that there were multiple differences in perceptions, attitudes and habits of food service workers regarding food waste. While some were proactive around issues of food waste and finding ways to curb waste, some were less concerned and not actively involved in its prevention. It was observed that those who appeared less concerned about food waste, easily discarded food without considering alternative ways of using excess ingredients or food produced.

FIGURE 5.20: CUTTING EXCESS INGREDIENTS CONTRIBUTED TO FOOD WASTE

In line with the categorisation of operations under the functional subsystem, the contribution of holding and reheating of food waste generation are discussed in the next subsection.

- *Distribution and service*

Certain practices undertaken during hot holding, contributed to food waste. The findings revealed that forgetfulness by food service workers and lack of communication caused food waste during hot holding (FG, O). This shows the interrelations between hot holding, inputs (human resources) and linking processes (communication) and their impact on food waste generation. For example, wastage of a roasted chicken leg (Figure 5.21) was observed when one of the food service workers forgot the chicken in the holding cabinet and failed to communicate to staff members responsible for service about this at the end of his shift. This chicken was found at the end of service and could not be saved for later use as it had previously been reheated.

FIGURE 5.21: REHEATED CHICKEN THAT WAS FORGOTTEN IN THE HOLDING CABINET

Another factor that contributed to food waste during hot holding, was keeping food for too long in the heated cabinets (FG, O, I). From a quality perspective, this practice led to overcooking of food and quality loss, such as drying and loss of colour. This is illustrated by the comments below:

> *"The food that is cooked is kept in the heated cabinets the whole day and it's very hot in there, from there it will be steamed again and put back in the heated cabinets. Like the rice from yesterday was put in the heated cabinets for lunch, and it was left there for supper, so it's like it is cooked a lot of times, from the*

heated cabinets it is kept in the bain-maries. It becomes overcooked and loses quality. You will see, there is rice in the heated cabinets for lunch and the ones remaining will be left there for supper and after supper they are going to keep the one left back in the fridge and tomorrow the same rice will be served.

"… yesterday at supper, a pan of vegetables was left in the heated cabinets for long and it changed color to brown, we couldn't serve it and we had a shortage, the supervisor had to come with an alternative plan and prepared vegetables for supper service".

Food waste was generated as a result of discarding food that lost quality due to prolonged hot holding times (D, O). Previous literature has not shown how prolonged hot holding can contribute to food waste. From a safety perspective, the food service unit regularly checked the temperature of food and ensured that food was kept at the appropriate hot holding temperatures. No food waste was thus observed as a result of inappropriate holding temperatures.

Additionally, the findings showed that holding more food than required, led to food wastage in the University food service system (O, FG). As previously discussed under overproduction of food, all the food that was overproduced was held hot in the heating cabinets without considering the forecasted number of students to purchase meals on that particular day or the amount of food already produced. This compromised the quality of food that remained after service and contributed to food waste, due to leftovers that could not be re-sold or consumed.

Under the ready prepared and commissary food production systems, food was stored frozen or chilled. Food wastage was experienced when the frozen or chilled food was stored and lost quality before consumption as a result of impropRer storage practices (O). For example, frozen cupcakes (Figure 5.22) lost quality during storage and were disposed of (D, O). This may be explained by the fact that frozen bread products undergo quality deterioration and changes in texture during the process of storage when exposed to large temperature fluctuations and storage at higher temperatures, than storage at constant and/or colder temperatures (Phimolsiripol, Siripatrawan, Tulyathan & Cleland, 2008).

The findings of the study further indicated that a considerable amount of food was wasted as a result of the reheating practices when using the cook-chill and cook-freeze system (O, D, G).

FIGURE 5.22: CUPCAKES WHICH WERE STORED FROZEN LOST QUALITY

Chilled or frozen food items were reheated in bulk and the food that remained after service had to be discarded since food could only be reheated once for safety reasons. Several food items were discarded as a result of this, for example 1½ pans of savoury rice and chicken was discarded after it was reheated and not consumed (Figures 5.23 and 5.24).

Records of food waste also indicated that food was wasted as a result of reheating. For example; nine (9) portions of chuck beef, two (2) pans of rice (Figure 5.25), a pan of mashed potatoes and carrots (Figure 5.26), and a pan of chicken chakalaka (Figure 5.27) were wasted as they were reheated in bulk and not consumed during service.

It needs to be pointed out that leftovers that usually were not exposed to the temperature danger zone, were reheated for the lunch service. During lunch service the meals were not booked, but production quantities were forecasted based on the history of meal statistics. However, the case University food service unit was located at a student residential area outside the University main campus, which meant that some students may have been away attending lectures, hence buying meals from food service units within the campus or within close proximity. Further to that, most of the reheated meals were leftovers from the previous day, which limited the variety of the menu provided. Such monotony in the menu might have

FIGURE 5.23: LEFTOVER REHEATED SAVOURY RICE AND CHICKEN

FIGURE 5.24: REHEATED SAVOURY RICE AND CHICKEN DISCARDED

FIGURE 5.25: PANS OF REHEATED RICE THROWN AWAY

FIGURE 5.26: MASHED POTATOES AND CARROTS WASTED

FIGURE 5.27: A PAN OF REHEATED CHICKEN CHAKALAKA WASTED

contributed to low purchases of reheated meals. Past research has not described how reheating practices or sales of reheated meals contributed to food waste in the food service system.

Additionally, it was observed that staff failed to adhere to the correct reheating procedures; no specific times and temperatures were adhered to while reheating food.

In support of these findings, participants commented that:

> *"There is a system where one would produce mixed vegetables, reheat them and reheat them again. Food gets spoiled from this frequent reheating".*

This affected the quality of reheated food, especially vegetables, which lost colour, hence the rejection by consumers. The safety of the food was also compromised. In this way, food waste was generated at the service point from food rejected by consumers. In reviewing the literature, no information was found on the association between reheating practices and food waste generation in the food service system.

The study revealed that both the centralised and decentralised delivery-service systems applied at the University food service systems, contributed to food waste. Where meals were produced in a central kitchen (centralised system) and assembled at the service point at a location close to the main kitchen, then served immediately to customers over the counter, it was found that food waste was generated mostly at the service point. The food waste generated resulted mainly from poor portion control and the rejection of food by customers, due to perceived poor food quality (FG, O). Where meals were produced at the central kitchen then distributed to remote sites (commissary food service system), use was made of a decentralised delivery-service system. In this system, food waste occurred as a result of changes to the forecasted numbers of consumers (O, I). The bookings for meals or cancellation of these by students were allowed until 0400 hours on the day of service. However, remote kitchens were required to order meals a day in advance from the central kitchen. This meant that meals ordered by remote kitchens could not be cancelled as the central kitchen would have already prepared the food. In cases where the number of meals ordered was higher than the actual number of students served, food waste was generated. This corroborates the findings of a previous study by Ofei *et al.* (2014), which showed that a non-flexible requirement of placing meal orders at the central kitchen three (3) days in advance and declining the request for cancellations based on changes in the actual number of patients at the wards, caused food waste.

In agreement with studies conducted by Papargyropoulou *et al.* (2016) and Rajan *et al.* (2018), it was found that the type of service style used by the food service unit had an influence on food waste generation. For example; the buffet and traditional cafeteria service styles produced a considerable amounts of waste. With the buffet service, overproduction of food that ended up unserved was a main challenge (I). A similar finding was made by Papargyropoulou *et al.* (2016). With regards to the traditional cafeteria service style, customers had an opportunity to request for an adjustment of food portions in line with their preferences (O, FG). While this might have reduced plate waste, it contributed to food waste generation at the service point. Food that was planned for service but was left over, resulted in waste when not properly managed.

The study further found that portioning practices caused food waste at the distribution and service point. The portioning practices contributed to food waste in two ways; inaccurate portioning and limited flexibility in portion size servings (O, FG, I). With regards to inaccurate portioning, it was observed that despite the presence of portioning guidelines and standardised portion sizes (*controls*), front-of-house staff often served more food than prescribed. Inconsistencies of the amount of food served, were also observed. This is demonstrated in the comments below:

> *"I think the portioning at service contributes to our waste because we over-serve and if you over-serve your yield is inaccurate. For me waste is not only what goes to the bin, for me waste is from the start to the end, it also means not getting the intended yield".*

Another participant commented that:

> *"Portions differ with different individuals, we all portion differently. We end up serving varying numbers, sometimes a lesser number or more students are served".*

These findings are consistent with that of Goonan *et al*. (2014), Heikkilä *et al*. (2016), Kasavan *et al*. (2019) and Pinto *et al*. (2018), who highlighted oversized portions and inconsistencies as common causes of food waste during service. Serving more food than the prescribed portion sizes may be due to attitudes and perceptions of food service workers about the portion sizes. The possible perception may be that the standardised portion sizes were too small to satisfy students. Servers often remarked that the White students as well as the female population were generally satisfied with small portion sizes, whereas Black students, and most males preferred larger portions. As such, they often served Black students and males with larger portions than specified. This possibly indicates the contribution of cultural differences and demographic factors on food waste generation. On the part of the University food service system, the large portion sizes were a waste. A possible explanation for the inconsistencies in portioning may be the lack of common understanding of standardised portion sizes among food service workers responsible for serving. For example, there was confusion about the standardised portion sizes for various food items, one saying the standard portion for rice is three spoons, the other saying two spoons; for vegetables some served one spoon, and the others half a spoon and the next, one and half spoons.

Additionally, poor portion control was observed specifically with starches, vegetables and sauces (O, I). Whereas portions of meat products were carefully counted from production to service, the same was not done for starches, vegetables and sauces (O, D). As such, a lot of starches, vegetables and sauces produced the bulk of the serving waste. These findings are in accordance with a study by Betz *et al*. (2015), who found that the largest area of food waste in two non-commercial food service establishments in Switzerland, was the serving losses of the starch and vegetable accompaniments, which constituted the bulk of the waste. A possible explanation for this is that the wasted food products had little monetary value compared to meat products, thus wasting them cost the food service unit less. This may indicate that the University food service unit placed more emphasis on financial implications of food waste rather than environmental and social implications.

In a few cases, errors such as food spillages were made during service, which caused food waste (O, FG). In agreement to this, one of the participants commented that:

> *"… when the student wanted to exchange the lasagna, it happened that the student gave back the lasagna and the bain maire was opened so it fell in the water".*

Previous studies have not indicated errors performed by food service workers as causes of food waste at the service point of the food service system.

In summary, the causes of food waste in the functional subsystem are represented in the framework in Figure 5.28 (next page).

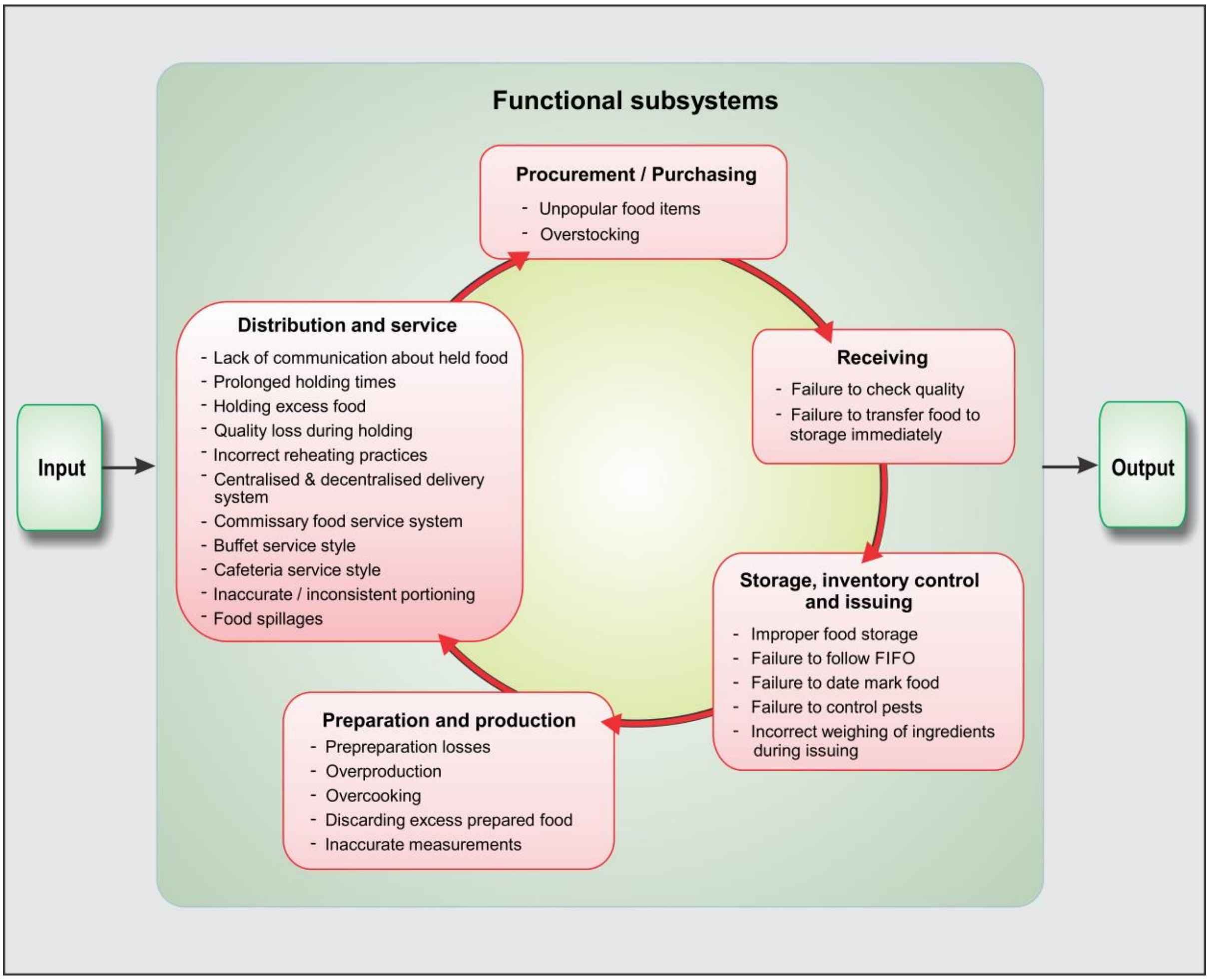


FIGURE 5.28: CONCEPTUAL FRAMEWORK OF CAUSES OF FOOD WASTE IN THE FUNCTIONAL SUBSYSTEM

5.2.2.2 Management functions

Different experts have classified functions of management differently. The authors like Koontz and O'Donnell (1972) have regarded management as a process that involves a series of functions, including planning, organising, staffing, directing and controlling. The current study applied the seven management functions developed by Luther Gulick (1973): planning, organising, staffing, directing, coordinating, reporting and budgeting (POSDCORB) (Payne-Palacio & Theis, 2016) and investigated their contribution to food waste generation in the University food service system. Generally, the findings of the study demonstrated that management functions had an influence on food waste generation in the University food service system (Figure 5.29).

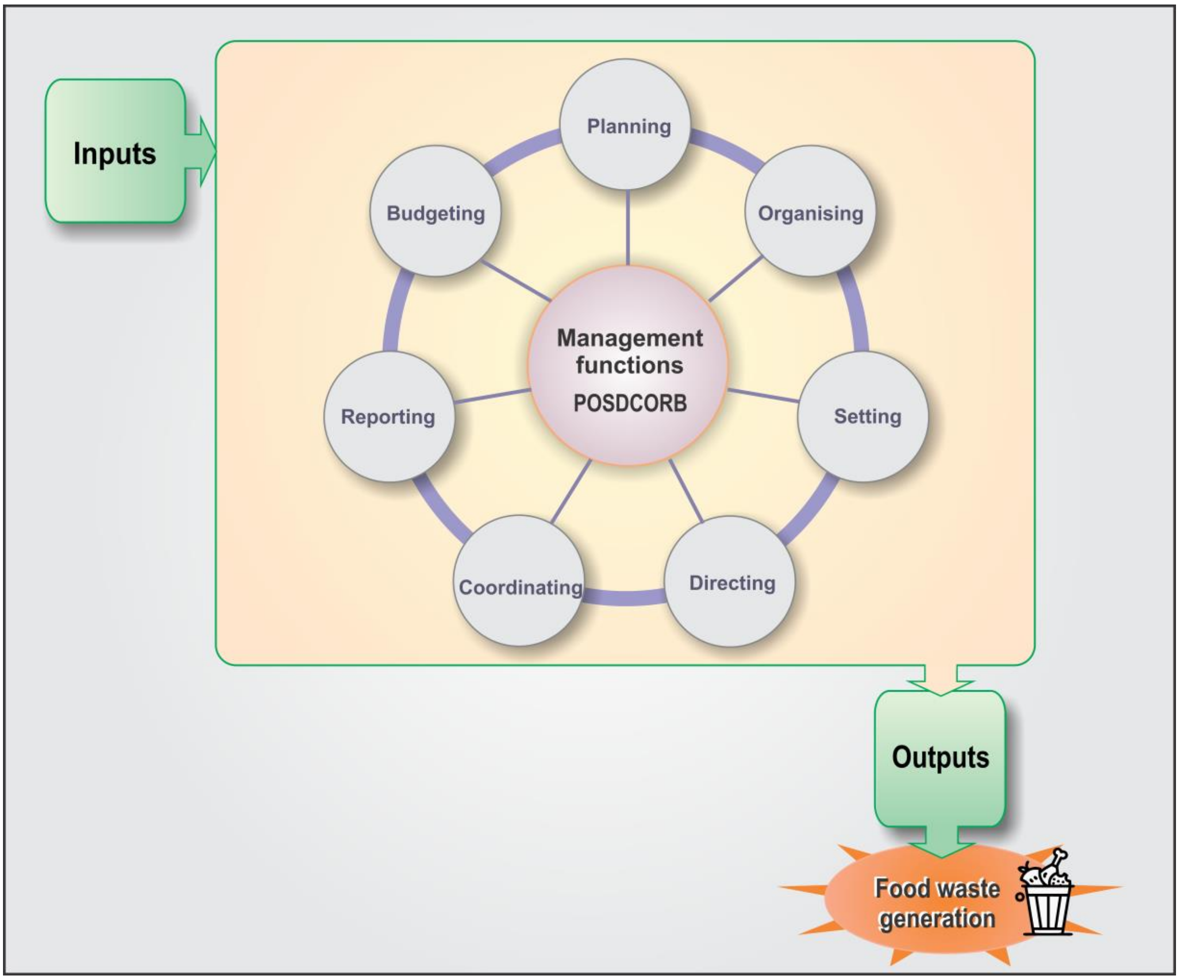


FIGURE 5.29: MANAGEMENT FUNCTIONS CONTRIBUTED TO FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SYSTEM

The following subsections include discussions on how each of the management functions contributed to food waste in the University food service system.

5.2.2.2.1 Planning

The planning function, which comprises the goals and objectives, policies, procedures and methods (Figure 5.30) had an influence on food waste generation to varying degrees. The next subsections include how each of these areas of planning contributed to food wastage.

- *Goals and objectives*

The goal of the University food service unit was to provide nutritionally adequate and quality meals to students at a reasonable and affordable price. In addition to that, better food waste

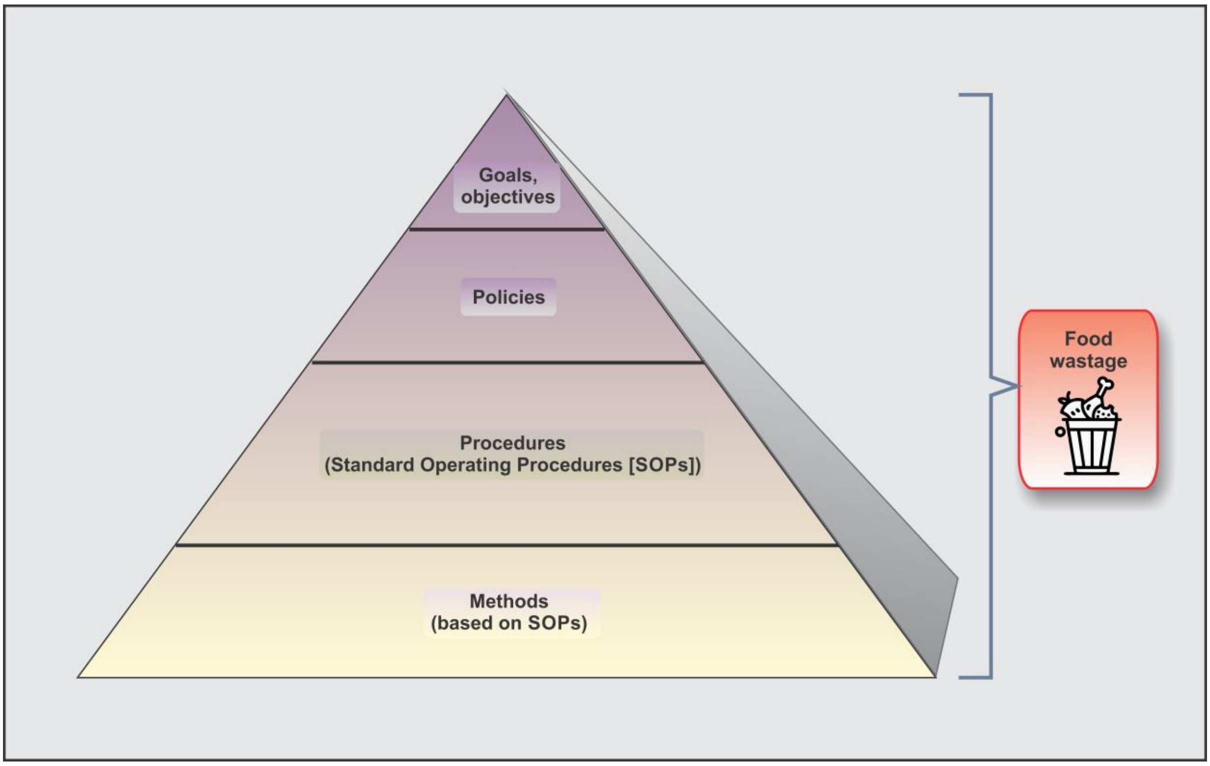


FIGURE 5.30: THE PLANNING HIERARCHY AND FOOD WASTE

management was an important objective, which the University food service management adopted as a cost reduction strategy. The provision of nutritionally adequate meals contributed to food waste (O, I). Specifically, the meal plan that stipulated the provision of starch, protein, vegetables and fruit, contributed to wastage as students tend not to choose salads and vegetables. This resulted in serving waste in this food category. Comparing the findings of the study with those of other studies, confirms that vegetables are large generators of food waste at the University food service unit (Marais *et al*. 2017). A possible explanation for this might be that students do not enjoy vegetables.

The other primary objective of the University food service operation was to cost reduction, such that food was produced at minimum cost and sold to students at an affordable price. This contributed to food waste in cases where the University food service unit predominantly chose suppliers based on the lowest bidder and at the expense of the quality of ingredients (I, FG). The interviews conducted indicated that some ingredients sourced were of poor quality but the buyer had to select the supplier as it was the cheapest in order to cut costs. However, this contributed to food waste as the cheap, poor quality ingredients led to the production of poor-quality menu items that ended up being discarded. This is illustrated in the comment below:

"… the herbs and spices that we have to order, because they are less expensive [and] we have to go with them, they are not of good quality".

Additionally, as indicated in Section 5.2.1.2, pans of cake were wasted as a result of using poor quality baking powder that was purchased on the basis of low cost. Previous literature on food service failed to discuss the influence of cost reduction on food waste generation.

- *Policies*

Although the University food service unit had enacted several food related policies that reduced food waste, strict food policies actually contributed to the food waste problem. Additionally, failure to comply with the requirements of policies or poor implementation by food service workers, somewhat contributed to food waste generation (O). The food quality policy largely helped prevent food waste, since improving the quality of meals increased acceptability thus reducing food waste (Ferreira *et al*., 2013). However, the food quality policy required that samples of each prepared menu item be kept for quality control; this resulted in accumulation of food samples that were discarded (D, O). Additionally, food items that were past their 'best before' and 'use by dates' were often not used for quality reasons (O). Adherence to the food safety policy helped maintain the safety of food, which prevented food waste that otherwise would have occurred if food was unsafe for consumption. However, the food safety policy restrictions caused food waste; these limited the use of leftovers food that were reheated twice, as well as food that was left at the temperature danger zone for two (2) hours or more. In agreement with this, Prescott *et al*. (2019) found that competing priorities, such as food safety policies conflicted with the schools' waste reduction efforts.

The University food service unit also employed a food waste management policy in the interest of curbing food wastage (D). It appeared that this policy was not openly communicated nor discussed with the food service workers (O). Research by Pirani and Arafat (2016) showed that mounting posters and signs in the kitchens helped in effectively implementing food waste management policies and encouraged staff members to reduce food waste. The same was not applied in the study of the case University food service unit. Failure to do this might have contributed to staff not implementing the food waste management policy. The food waste policy mainly emphasised that a food waste audit trail be conducted (O, D). Food service workers did not always record food waste, and/or recorded inaccurate amounts of food waste than the actual waste generated (D, O). As discussed in Section 5.2.1.1, this was attributed to feelings of guilt and having a fear of possible disciplinary action by management as a result of generating food waste. This led to the failure to effectively plan strategies to reduce food waste, as the records were inaccurate and portrayed an inexact picture. This finding is consistent with Sonnino and McWilliams (2011), who found that food waste in three Welsh hospitals was under-recorded by ward staff, hence resulting in ineffective food waste management.

The food service workers also failed to follow the food waste policy on the handling of leftovers, which led to food waste (I, O). This is indicated in the comment below:

> *"There is a leftover policy, did you read the leftover policy? It's in the procedure file. I don't really think we follow that, I think we can sharpen on that".*

Specifically, as highlighted in the previous sections, in some instances, food service workers failed to store leftovers correctly, and failed to reheat them according to the set procedures (O). This resulted in spoilage of leftovers, hence food waste.

- *Standard Operating Procedures (SOPs)*

The University food service unit had several standard operating procedures (SOPs) that were applied on a daily basis. This included SOPs for employee health and personal hygiene, equipment cleaning and sanitising, use of thermometers, facility and equipment maintenance, purchasing, receiving, storage, temperature recording for cold storage, thawing food, preparing food, cooking, holding food, cooling food, reheating food and service of food. The findings of the study demonstrated that the lack of adherence to standard operating procedures contributed to food waste generation (O, I). For instance, failure to follow reheating procedures compromised the safety and quality of food, which led to food waste generation (O, I). The current literature has not demonstrated the contribution of failing to adhere to SOPs on food waste generation.

5.2.2.2.2 Organising

This function of management involves the development of the formal organisational structure through which work is divided, defined and coordinated (Payne-Palacio & Theis, 2016:357).

The organisational structure of the University food service unit is shown in Figure 5.31. The food service organisation was structured, such that work was specialised according to the stages of transformation of the food service system. Within each stage, the division of work was predominantly rotational with a few tasks allocated on the basis of specialisation, considering the skills of the food service workers. The study showed that the division of work on a rotational basis rather than specialisation based on the skills contributed to food waste (I). The production supervisor pointed out that they used to have a lot of waste of desserts when food service workers were assigned the production of desserts on a rotational basis. After appointing a chef responsible for the production of desserts, food waste in this section declined.

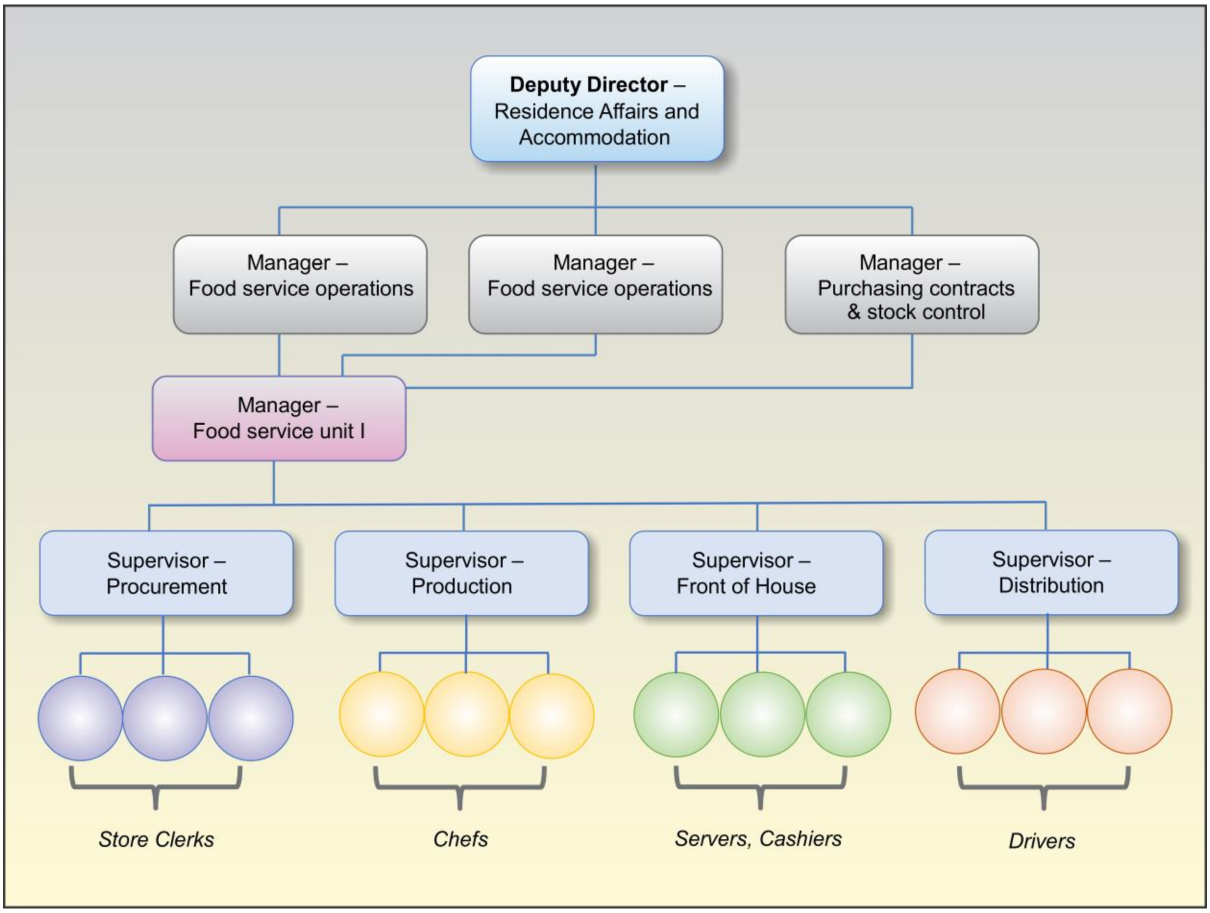


FIGURE 5.31: THE ORGANISATIONAL STRUCTURE

Another element that might have contributed to food waste was that there were no staff members who were directly responsible for food waste management. Even though supervising staff felt mandated to prevent food waste and made efforts to implement food waste prevention strategies, some of the staff members at operational level did not feel accountable for food waste prevention (O, FG). According to Marais *et al*. (2017), to effectively prevent food waste, food waste management committees or structures need to be inclusive of catering personnel in order to develop and implement waste management endeavours.

5.2.2.2.3 Staffing

The findings of the study showed that the most critical aspects of staffing, including recruitment and selection, training and development, had an influence on food waste generation (Figure 5.32). The study was unable to establish the influence of other aspects of staffing; performance appraisal and compensation on food wastage.

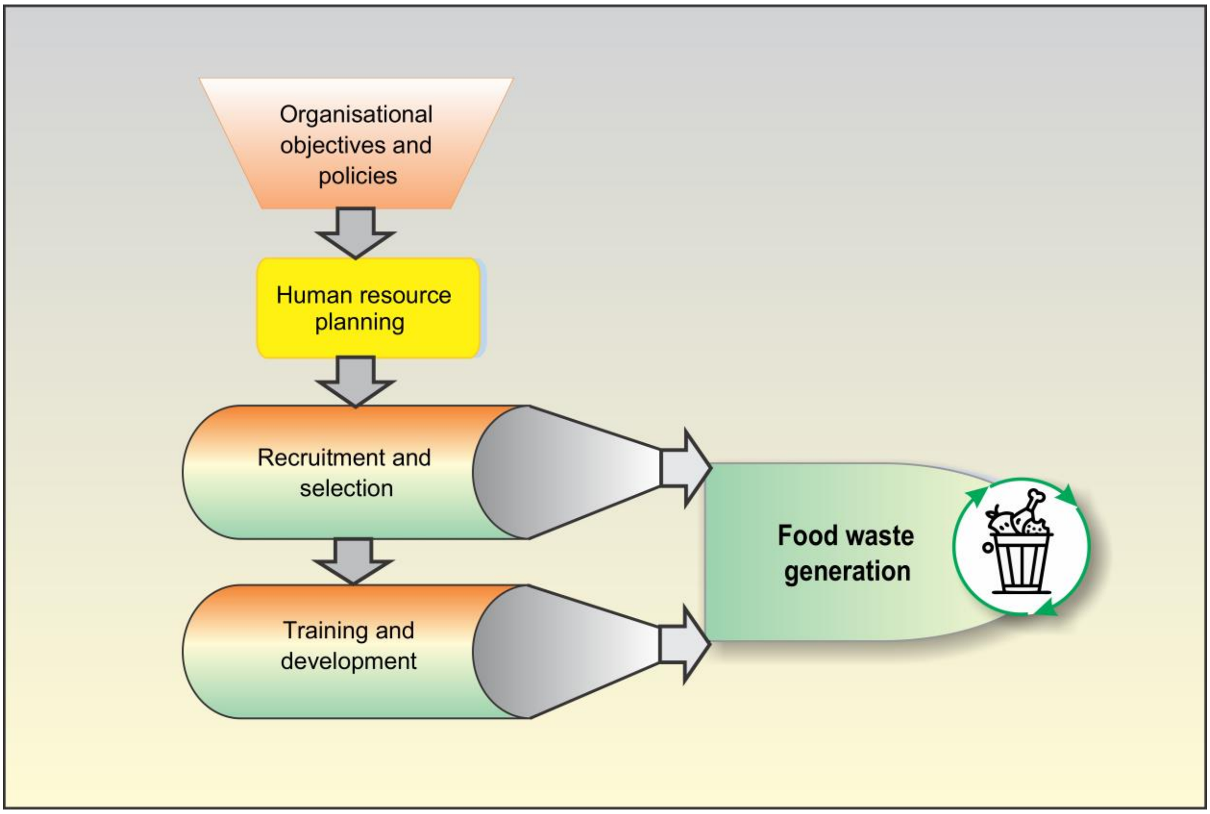


FIGURE 5.32: THE INFLUENCE OF STAFFING AND FOOD WASTE

As discussed under Section 5.2.1.1, the recruitment and selection of untrained staff, with no prior experience in the food service industry, contributed to food waste (FG, O). This was because they were inclined to make mistakes during food production, hence food waste. In addition to that, the lack of in-service training exacerbated the food waste generation problem (I, O). Concerns were expressed about food service workers failing to perform operational practices due to the failure to provide in-service training for them. This is expressed in the comment below:

> *"... there are specifications but I think at the point of receiving the specifications are not always followed or checked. The assistant managers are playing a role in checking the quality but they are now moving that responsibility over to stock clerks with what training"?*

Further to that, the University food service unit failed to provide in-service training on food waste prevention strategies or on how different operational practices are important to minimise food waste. According to Filimonau and De Coteau (2019), this can make employees reluctant to engage in food waste prevention and thus obstruct any progress towards the mitigation of food waste. The provision of continual training is important so that food service workers can embrace new techniques and strategies to mitigate food waste (Filimonau & De Coteau, 2019). This indicates that more explicit training programmes that are specifically focused on food waste reduction, would be beneficial.

5.2.2.2.4 Directing

The findings of the study showed that failure by management to give clear instructions, guide and supervise food service workers contributed to food waste (FG). A similar finding was reached by Charlebois *et al*. (2015), who indicated that the manner in which management supervised various kitchen activities had an influence on the creation of food waste. One of the participants commented that:

> *"For us it's difficult to report anything to management because of the way our supervisor addresses us when we report issues, like yesterday when I reported the issue about rice the supervisor said to me "why do you serve students spoiled rice, didn't you notice that rice was spoiled?", how would I notice that when I am busy at work, it's her work, when would I have time to taste".*

This illustrates that failure by management to guide and address issues raised by food service workers by communicating inappropriately influenced the generation of food waste. This may suggest that failure to address issues raised by workers denies management the opportunity to gain valuable information that could help mitigate food wastage.

In agreement with this another participant commented that:

> *"The problem with our supervisor is that when you report something she says you have to report to management yourself. Yesterday I was very hurt, I told her that the burger buns are getting finished; there were a lot of meat patties and only [four to five] (4 - 5 buns) left and she said I have to report to the Stock Clerk and I don't have the power to tell the Stock Clerk to give me more buns".*

Another participant further elaborated on this issue:

> *"The problem is when the beef patties are left without burger buns because we can't sell patties without buns. What we need is for our supervisor to know that she is responsible for reporting issues to management herself."*

In this case, accountability was shifted from management (the supervisor) to the staff members and in the end, no one made the requisition for the burger buns, which resulted in wasting the beef patties.

It was further indicated that inconsistencies by management directing food service workers influenced food waste (FG, O). During observations, one of the participants remarked that some food service workers are favoured over others and are never disciplined for failure to execute duties, which led to food wastage. For instance, it was mentioned that a certain favoured food service worker kept pans of meat in an undesignated area, resulting in serving staff not serving the meat as they were not aware of where it was kept. This resulted in spoilage of the meat, hence food waste. The matter was reported to the supervisor and she did not address the responsible employee. As a result, other employees did not find it necessary to prevent food waste. A similar finding was indicated in a study undertaken by Charlebois *et al*. (2015), which showed that food service workers did not go the extra mile in their work nor place any effort to prevent food waste, while other staff members were not addressed in areas where they failed.

5.2.2.2.5 Coordinating

Coordination of the day-to-day kitchen activities had an impact on food waste generation and prevention. There is interrelatedness and interdependency between coordinating and other managerial functions, as well as other parts of the food service system.

The findings further provided evidence that the lack of routine monitoring of food waste aggravated food waste generation (D, O). Food service workers were expected to record and report food waste through a food waste-tracking tool, called the Z or Monday report. However, during observations, a considerable amount of food waste was created but not recorded (O, D). A similar observation was made in the study conducted by Ofei *et al.* (2014), where no data was collected on food waste from wards, mainly because of a lack of appropriate methods to adopt monitoring as part of the food waste routine. Failure to accurately record and monitor food waste deprived management of the opportunity to devise appropriate corrective measures to mitigate food waste based on a true reflection of the level of actual food waste generation.

Additionally, top management of the University Food Service division conducted regular inspections to assess the adherence of University residential food service units to policies, procedures and quality standards. It clearly shows that the inspection tool overlooked an important area - food waste management and therefore, there was no focus on food waste during inspections.

5.2.2.2.6 Reporting

The findings of the study indicated that the lack of or poor reporting contributed to food waste (I, O, D). This management function can be related to both the memory- and the communication element of the linking processes. The major factor contributing to food waste under this management function, was unreported waste, which limited the opportunities for management to provide mitigation measures to prevent food waste (I). Additionally, poor intradepartmental reporting or communication, interdepartmental communication and communication between management and staff members contributed to food waste. This is discussed at length in Section 5.2.2.3.

5.2.2.2.7 Budgeting

Most of the aspects of budgeting played an important role in preventing food waste at the University food service unit. However, a limited or restricted budget often meant purchasing cheap food products that were not necessarily the best quality (I, D). Compromising the quality of food products for price led to the production of poor-quality products, which were rejected by consumers, hence generating food waste.

5.2.2.3 Linking processes

Communication, decision-making and balance are the linking processes that are used to help coordinate the work in a food service operation towards the attainment of its goals (Gregoire, 2013: 333). The next section discusses how failure of proper linking processes contributed to food waste generation in the University food service unit.

- *Communication*

Under the linking processes, ineffective communication across different levels of food service workers was found to be a major cause of food waste (I, FG). This is comparable to the findings of studies conducted by Goonan *et al*. (2015); Goonan *et al*. (2014); Heikkilä *et al*. (2010); Kasavan *et al*. (2019); Ofei *et al*. (2014) and Papargyropoulou *et al*. (2016). It was specifically indicated that poor intradepartmental communication, interdepartmental communication, and communication between management and staff members contributed to food waste. In line with this, a participant commented that:

> *"We have a communication problem. We have to tell our supervisor that we will not accept any food items from the kitchen that is not date marked. Sometimes production staff make us accountable for their mistakes, for instance, they once gave us watery mince-meat and it also failed the probe test and they said we are the ones who put water on the mince-meat and that was not true, they gave it to us in that form. They give us waste".*

Another one commented:

> *"The same goes for yesterday, I went for lunch, when I came back from lunch to service I looked for meat where we always keep it and I didn't find it, after some time we found the meat where we keep rice and by then students had already left without meat, so we had meat leftover which cannot be sold so that's another problem that is going to cause waste. That is the waste that we staff members cause".*

It was further added that:

> *"All we need is communication, because we know where we should keep meats and starches so why should someone put meat where they are not designated*

and knock off without communicating about where he kept the meat? The next person wouldn't think of checking meat in such areas, because no one would guess meat would be kept there, we only found it after service when packing and the responsible person would say "I thought you would find it"?

"How would I find it when he did not communicate? That's the problem we are facing in front of the house, but we don't know how to solve it because someone will tell you that you are not my supervisor, don't tell me how to work".

In this case, poor communication between production and front-of-house departments, and between front-of-house staff members generated food waste. Additionally, failure to communicate issues causing food waste to management, further exacerbated the problem. Without effective communication, practices, which contributed to food waste remained unknown, hence not addressed.

Lack of communication or ineffective communication between the food service unit and customers had an influence on creating food waste. This factor interrelated to the feedback part of the food service system. The food service unit communicated with the students (customers) through the meal complaint system. However, a concern was raised that when the students communicated their needs, preferences and complaints through this forum, the University food service unit was not reactive to the complaints. One of the participants in this study commented that:

"Students say they raise complaints and there are no changes".

In support of this, Marais *et al.* (2017) indicated that ineffective communication between students and caterers means that meals continue to be served that do not satisfy the needs, and the expectations of customers, which results in food waste.

- *Decision-making*

By involving food service personnel in decision-making, the influence of food waste generation differs with the various levels of workers. Permanent, experienced food service workers with a long service record at the University food service unit, showed concern and consciousness about food waste, thus they took the initiative to reduce waste (O, FG, I). However, temporary and less experienced food service workers, who had not served for long at the University food service unit, felt that it was not their responsibility to take measures against food waste, hence they tend to generate food waste. (O, FG, I)

The study further revealed that the decision-making approach adopted by management had an influence on the creation of food waste. Where there was no clear understanding of the types of decisions made across different levels of management, this resulted in failure to make pertinent decisions that could have prevented food waste (I). For example, management made the decision to stop selling menu items left over from the University food service unit at the mini-market (University grocery store) without consideration of suggestions from lower management and this led to food waste. One of the participants commented that:

> *"… what we did in the past was that when the combo service ended, we transferred remaining food items to the mini market for sale, now the top management has stopped that, they say we should not sell food in the mini market".*

> *"We had vegetarian meals that were sold in the mini market as frozen, they have stopped that because we don't have approval to sell in the mini market. I told them that to make vegetarian food in the dining hall causes waste because you make five and only two students come and collect so rather sell it frozen and they can warm it when they want. So the system, I don't know whether to call it a bureaucracy or policy can really directly influence your waste".*

This shows that failure of top management to empower lower management and allow them to make programmed decisions concerned with day-to-day activities, contributed to the creation of food waste in the University food service unit.

- *Balance*

Balance refers to managerial adaptations to changing economic, political, social, and technological conditions (Gregoire, 2013:356). These environmental factors and how they contributed to food waste are discussed in Section 5.2.7. In most cases, management responded to changing conditions in order to reduce food waste. This is discussed in Chapter 6. In some cases, management failed to respond to changes or external forces which contributed to food waste. For example, balancing food waste reduction with food safety requirements as per the national and in-house policies was challenging (FG, I). The regulatory requirements around food safety and hygiene allowed reheating of leftover food only once, which contributed to food waste at the University food service unit. The participants of the study commented that:

> "*Repeated reheating is a problem that leads to wastage. The requirement is that we have to reheat leftovers once and throw it if any is left over."*

Another participant commented with a deviating understanding:

> "*You can only warm food twice then it becomes waste."*

Another one also remarked that:

> *"If, say we have warmed the food twice we can't use it and we record it as waste."*

The findings indicate that participants agree with the food safety regulations of reheating, as well as limiting the use of leftover food. Additionally, the comments indicate a lack of understanding of the regulatory requirements around reheating, which further exacerbated the problem of food waste. In this case, such food safety requirements could not be compromised for the sake of reducing food waste. This concurs with the findings of the study by Kasza, Szabó-Bódi, Lakner and Izsó (2019), who indicated that it is difficult to find a balance between food waste reduction of leftovers and expired foods, and food safety requirements.

5.2.3 Controls

Internal and external controls used at the University food service system had an influence on food waste generation. These included the menu, contracts and quality controls, which are discussed in the next subsections.

5.2.3.1 The menu

The fixed menu used for booked meals contributed to food waste at the University food service unit (O, I, FG). For instance, on the menu a meat, starch, vegetables and dessert must be offered. However, it was observed that students often chose not to have the vegetables at the point of service, while some also left the dessert. This led to wastage of vegetables and desserts as they would have been prepared according to the fixed menu and the number of students who had booked. In line with this finding, a study conducted by Marais *et al*. (2017) indicated that dessert, followed by vegetables contributed to a large percentage of the total food waste at Stellenbosch University food service units.

5.2.3.2 Contracts

The contractual clauses between the University food service unit and the suppliers prevented food waste at the food service operation level. (This will be discussed in detail in Chapter 6). However, failure to strictly adhere to the stipulated contract agreement, caused food waste on the part of the University food service operation. For example, in cases where the suppliers failed to meet the food specifications stipulated in the supplier-food service operation contract, the food service unit ended up with substandard ingredients that often resulted in food waste generation (O, I). As discussed under Section 5.2.1.1; failure of the supplier to supply the size of beef cuts specified by the University food service unit led to monetary food waste. Additionally, as indicated in Section 5.2.2.1, failure of suppliers to supply ingredients of the quality specified on contracts, and acceptance of such ingredients by food service workers responsible for receiving, led to food waste.

The findings of the study further revealed that the contractual agreement between the University food service unit and students, concerning the specifications of the meal plan, contributed to food waste (O, I, FG). As discussed in Section 5.2.3.1 above, the menu specified that meat, starch, vegetables and dessert must be offered. However, wastage of vegetables and desserts was observed as a result of students not wanting these. Despite this observation, the University food service unit could not stop offering these options as it was contractually bound to the agreed meal plans and any deviations would be regarded as a breach of contract. In accordance with these findings, Marais *et al*. (2017) demonstrated that fixed contractual agreements on meal plans between the caterers and students contributed to food waste at Stellenbosch University.

5.2.3.3 Quality controls

A number of quality controls, including standard operating procedures, were developed and put in place across the different stages of the University food service system. However, failure to adhere to or implement controls contributed to food waste (I, FG). For instance, as discussed under Section 5.2.1.1, quality specifications were developed but where food service workers did not implement them at the time of receiving, poor quality ingredients were received and ultimately discarded. At the production stage, participants highlighted that on some occasions, food was wasted as a result of failing to follow standardised recipes. This practice resulted in the production of poor-quality products that were rejected by students, hence wasted. In some instances food waste resulted from the use of recipes that were not standardised. This is illustrated in the comments below:

> *"Recipes that are not very specific contribute to food waste, to say you must fry for 20 minutes, not including factors like temperatures, there are recipes that lack [in] temperatures."*

> *"Sometimes recipes that are not standardised affect the quality of food. For example, there is a recipe for pineapple pudding that had too many ingredients so the products always flopped so we reduced ingredients like sugar, baking powder."*

The study further revealed that some quality controls were bottlenecks to the reduction of food waste. As discussed in Section 5.2.2.2, food safety regulations and standards limiting the use of leftover foods, contributed to food waste.

5.2.4 Memory

The findings of the study indicated a link between the memory element and food waste in the University food service system. Inaccurate forecasting as a result of the failure to consider past records of meal statistics, contributed to food waste (I, D). This has been discussed under overproduction in Section 5.2.2.1. In addition to this, forecasting based on records from the pre-booking system led to food wastage. This has been discussed under Section 5.2.2.1 as a non-flexible practice that generated food waste when meals that were booked were not taken, and when students cancelled bookings after preparation was completed. The findings correspond with previous research (Painter *et al.*, 2016; Marais *et al*., 2017) conducted in the South African university food service context, which indicated the failure of students to collect booked meals was a cause of food waste. In agreement with the findings, Ofei *et al.* (2014) also showed that predicting the number of customers based on the pre-booking system, is an unreliable method that generates waste as a result of changes in the actual number of customers served on that day.

Table 5.4 indicates a record of meals booked and not taken on the 2nd September 2016.

TABLE 5.4: FOOD TRACK RECORD OF MEALS BOOKED AND NOT TAKEN

	BOOKED	COLLECTED	OUTSTANDING (NOT COLLECTED)
Vegetarian supper	1	1	0
TuksRes sunrise (breakfast)	16	15	1
Standard supper	35	29	6
TuksRes sunset	72	63	8

Table 5.4 shows the most uncollected booked meals during supper (standard supper and TuksRes sunset). A possible explanation for this might be that students are not always able to collect their pre-booked meals due to reasons such as: having made other meal plans, not having time to walk from the main campus to the University residential food service unit, forgetfulness, lectures ending late, and their unavailability while studying (Painter *et al.*, 2016; Marais *et al.*, 2017). The University food service unit had an arrangement that students could make a written request for someone to collect their meals when they were unable to do so. However, this arrangement was not frequently used. The reason for this might be that students may have not anticipated missing the meal service, hence their failure to make alternative arrangements in time.

Another factor that contributed to food waste was inaccurate recording of leftovers and food wasted. As discussed in Sections 5.2.1.1 and 5.2.2.1 some food service workers did not record and/nor adjusted records of leftovers and food waste generated at their stations (FG, O). Additionally, the food waste audit tool did not require food service workers to record leftover food items of the starch and vegetables (D, O). Other forms of waste such as off cuts were also not recorded. This meant that the record of leftovers did not reveal a true picture of the actual quantity of leftovers and food waste, hence an underestimation of the level of food waste generated. In turn, this possibly made it difficult to plan around the use of leftovers. Unreported waste also limited the opportunities for management to provide mitigation measures to prevent food waste (I).

The University food service unit kept records of the food inventory through the automated stock management system (RCL) as well as the manual record of the stock movement. As discussed in Section 5.2.2.1, it was observed that when overstocked ingredients were about to expire, the production unit was informed and planned the menu around those ingredients (O). One of the participants mentioned that, at times the production team is given an inventory record of what is due to expire shortly. This led to overproduction of food items that were about to expire without considering the actual number of anticipated customers. This created food waste at the production and service points.

5.2.5 Outputs

As discussed in Chapter 2, the primary outputs of the food service system are the quality and quantity of meals, customer satisfaction and financial accountability. In this study, excess quantity of meals, poor meal quality, customer dissatisfaction and lack of financial accountability contributed to food waste generation as discussed in the next section.

5.2.5.1 Excess quantity of meals (overproduction)

The findings of the study demonstrated that the quantity of meals was an important output, which had an impact on the amount of food waste generated (O, I, D, FG). Overproduction of meals required by customers was the major cause of food waste, as often the excess food items, which could not be consumed, were discarded. This has been discussed in detail in Section 5.2.2.1.

5.2.5.2 Poor meal quality

The findings showed that poor quality meals resulted in service waste. Sub-optimal preparation and reheating methods of food items resulted in visually unappetising dishes thus increasing wastage (FG, O). For example, reheated vegetables (Figure 5.33) lost colour, texture and taste, which appeared unattractive to students. In support of this, Heikkilä *et al.* (2016) mentioned that individuals tend to rely on the appearance of food, smell or taste to judge whether it is edible or not. When these characteristics are poor, customers do not purchase the food, hence food wasted. Similarly, other scholars; Marais *et al*. (2017), Williams and Walton (2011) and Wu *et al*. (2019) found that poor quality meals resulted in food waste.

The findings of the study further showed that a combination of several factors, including procurement of poor-quality ingredients, poor storage, poor handling, poor food production and holding, incorrect temperatures, incorrect timing, and poor equipment maintenance, contributed to the final quality of meals (FG, O, I, D). This indicates the interrelatedness and interdependency of activities across different stages of the food service system.

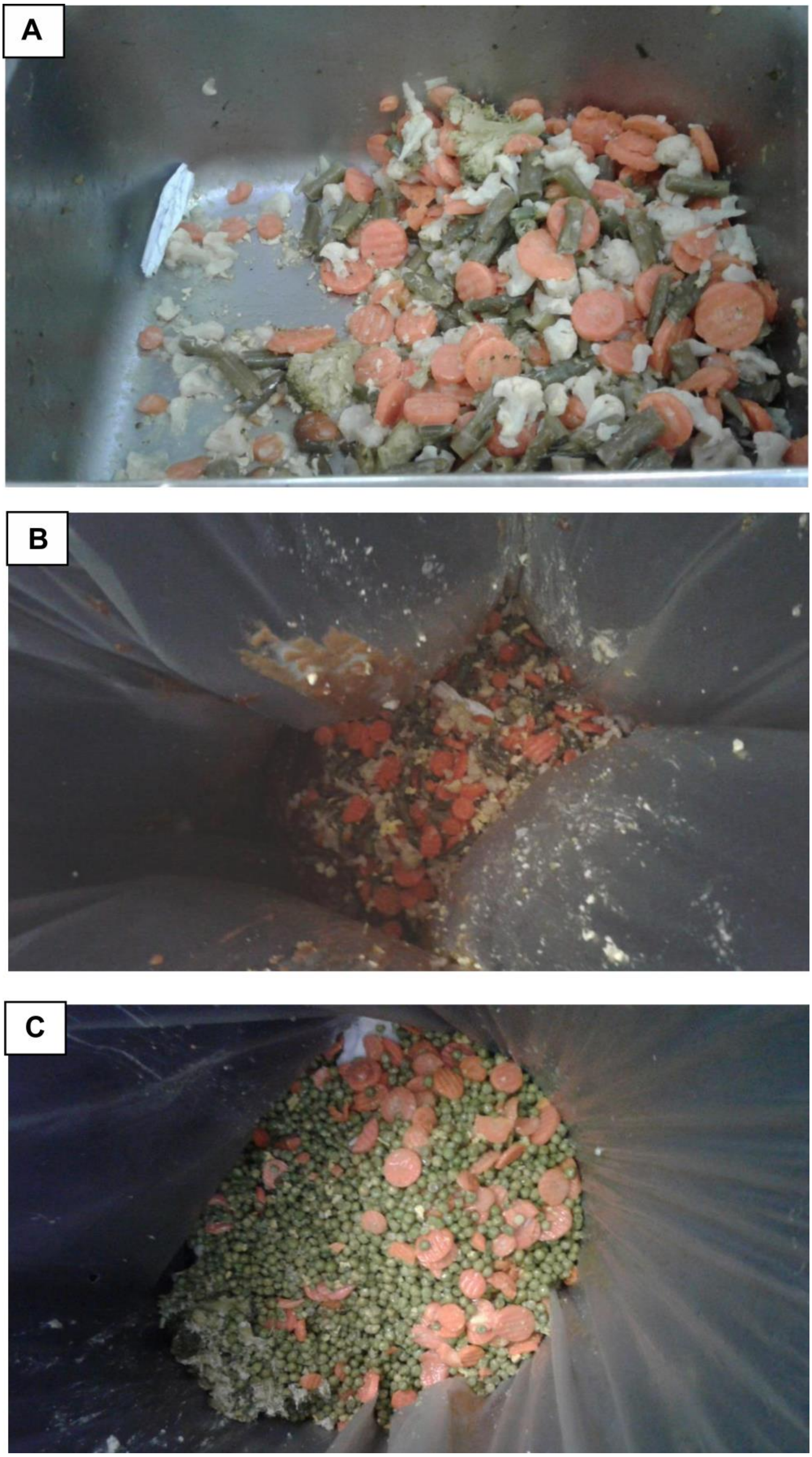


FIGURE 5.33 (A, B. C): VEGETABLES DISPOSED OF AS A RESULT OF LOSS OF QUALITY

5.2.5.3 Customer dissatisfaction

The negative perceptions of customers regarding the food they were served at the food service operation contributed to food waste generation. Specifically, failure to meet customer expectations of the sensory characteristics of food, such as the taste, colour, texture, variety, temperature, appearance, aroma and freshness, resulted in less food purchased, hence waste (FG). This is illustrated in the comment below:

> *"Yesterday we had a student complaining that the rice they are served has got too much water so they can't eat it they often go for potatoes."*

Do Carmo Stangherlin and De Barcellos (2018) also mentioned that dissatisfaction of taste and freshness of food led to customers leaving food unconsumed, leading to service and plate waste. Similarly, Heikkilä *et al.* (2016) showed that failure to meet customers' images and expectations for the food being served, contributed to food waste.

The study further indicated that some measures put in place to reduce food waste, for example the use of leftovers, compromised the quality of meals, leading to customer dissatisfaction, hence food waste generation. This illustrates the linkages or interdependency between different elements affecting food waste in the food service system. Maintaining an equilibrium between these elements is thus important in preventing food waste.

5.2.5.4 Lack of financial accountability

Another factor, financial accountability, was found to have an influence on food waste in the University food service units. This concurs with findings of the study conducted by Goonan *et al*. (2015), which indicated that food service personnel and managers, who failed to attach food waste to financial loss, tend to remain wasteful. In the current study, managers clearly attached food waste to financial loss thus they tried to have measures to prevent food waste (I). However, some food service workers failed to realise the cost implications of food waste and remained wasteful (O). For example, when some food service workers reached the required yield specified in the recipe, they discarded the remaining ingredients (Figure 5.34). When asked if they did not consider the cost implications of such waste, they responded that the University makes enough money to purchase food ingredients. This illustrates that some food service workers at operational level failed to take the responsibility to control costs, hence the failure to minimise food waste.

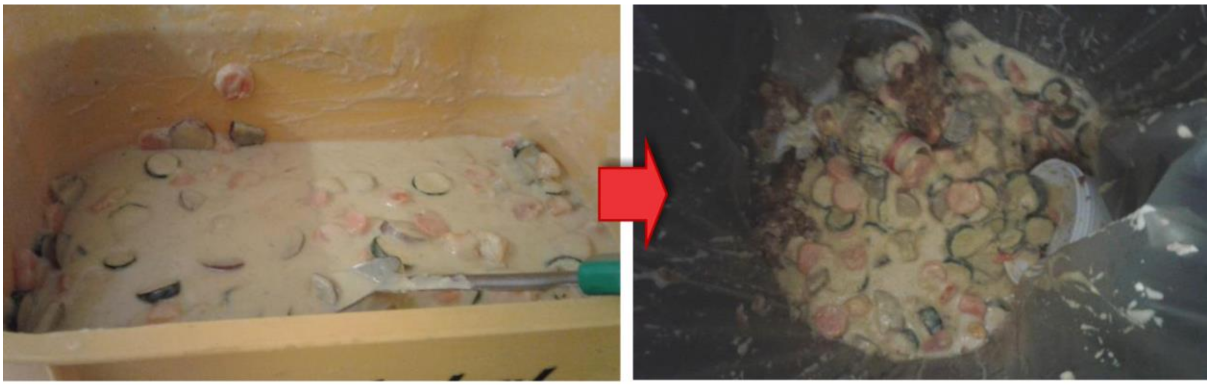


FIGURE 5.34: VEGETABLES WITH SAUCE DISCARDED AFTER REACHING THE EXPECTED YIELD

5.2.6 Feedback

Several factors concerning feedback, contributed to food waste. First, the ineffective implementation of the meal complaint system caused food waste. At the case University food service unit, a meal complaint system was available to continually obtain feedback from customers. However, some customer complaints were not addressed. This is indicated in the comments below:

> *"Students say they raise complaints and there are no changes."*

Another one added:

> *"They complain a lot, they are no longer eating rice and they eat potatoes instead."*

> *"There are a lot of complaints raised by students but we just tell them that they can raise their complaints through emails, we don't report to management, our answer is always 'go and write an email'. Our regulations don't allow us to inform students about ingredients contained in food, even if students can ask if for example, the Russians contain pork I should not answer. I have to say I don't know and consult the supervisor and ask them to address students on what is contained in the food".*

Another participant further elaborated on the issue and reasoned that:

> *"I asked the manager why she does not implement some changes requested by students, like have a variety of food and she said she does not have the power*

> *to do any changes but the Director does not allow her because he tells him about the budget, prices and costs."*

As indicated above, failure to address customer complaints resulted in students rejecting some menu items which ended up being wasted. This demonstrates that without effective feedback mechanisms, the University food service unit became a relatively **closed system**. These findings corroborate those of the previous work by Marais *et al*. (2017), who indicated that without effective feedback from customers, meals that do not satisfy the needs and expectations of customers, continue to be served, which results in food waste.

Failure to share feedback on food waste between food service workers at operational level, and supervisors and managers, affected food waste generation (FG, O). In this study, food waste was recorded by Departmental supervisors on the Monday report tool and shared between the food service unit manager and supervisors in management meetings. However, this information was not passed down to food service personnel to make them aware of the amount of food wasted. In line with this, Goonan *et al*. (2015) argued that if feedback about food waste is not shared between management and food service personnel, it may lead to food service workers feeling that they are not compelled to adhere to food waste prevention practices.

In addition to this, failure to put feedback mechanisms in place to obtain feedback from staff members might have influenced food waste generation (FG).

One of the food service workers commented that:

> *"We used to hold meetings every Monday with our previous supervisor but since she left we no longer hold meetings. We used to raise complaints, how we are working and other complaints were raised during such meetings. So, we don't know how this can be remedied."*

Failure to obtain information and complaints from staff might have deprived management of the opportunity to address or reduce food waste (Kasavan *et al*., 2019; Ofei *et al*., 2014).

5.2.7 Environmental factors

The findings of the study indicated that both external and internal environmental factors contributed to food waste generation in the University food service system, as illustrated in Figure 5.35. These are elaborately discussed in the following sections.

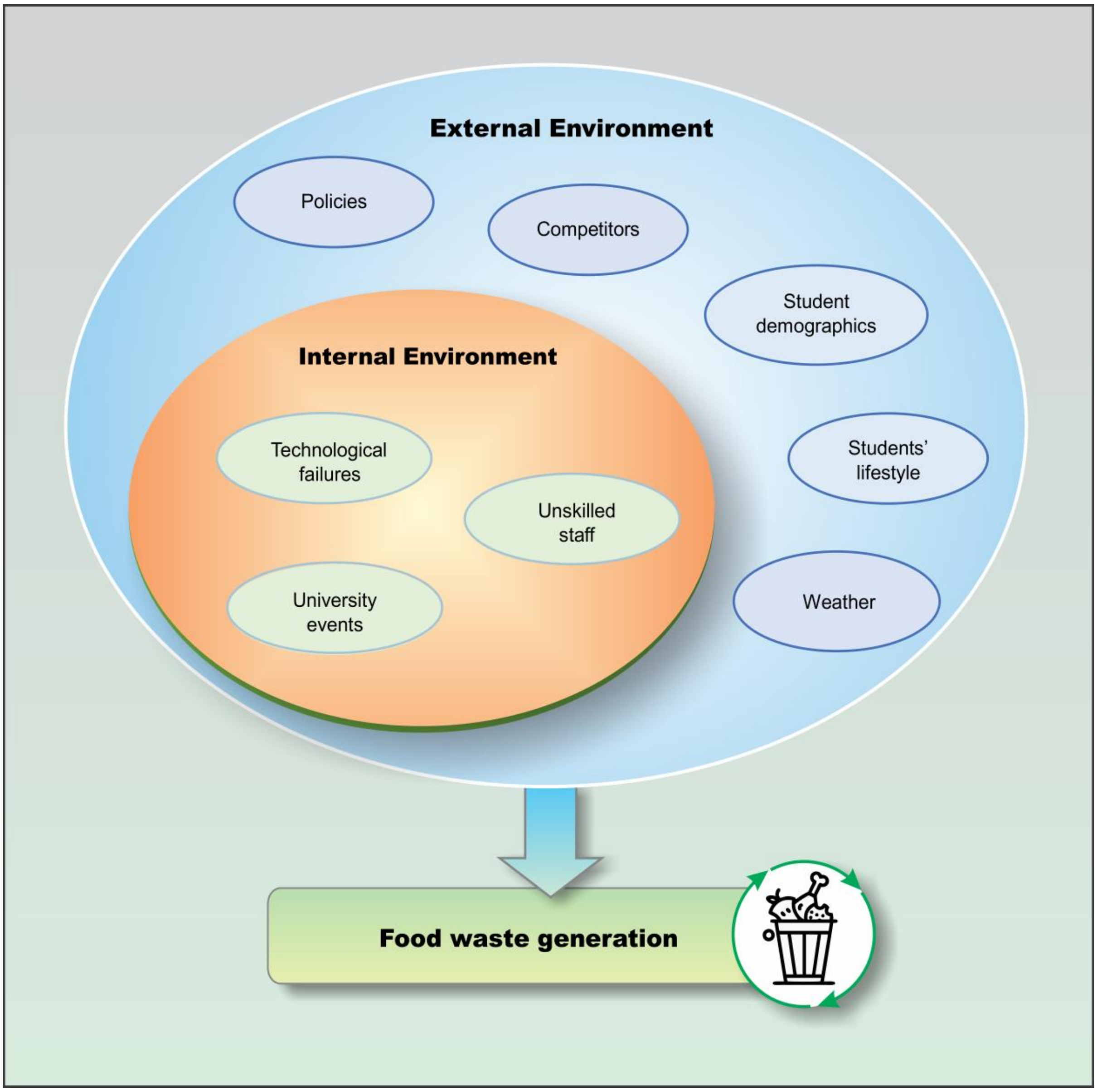


FIGURE 5.35: ENVIRONMENTAL FACTORS CONTRIBUTING TO FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SYSTEM

5.2.7.1 External environmental factors

The next subsection discusses the external environmental factors, including policies, competitors, student demographics and lifestyle, and the weather conditions, which influenced food waste generation in the University food service system.

- *Policies*

Policies and regulations around food safety limited the re-use of reheated leftover foods and this resulted in food waste. This study discussed how food safety policies contributed to food waste under Sections 5.2.2.1 and 5.2.2.2.

- *Competitors*

Competitors were identified as having an influence on food waste generation at the University food service unit (FG). This is indicated in the following commentary by one of the food service workers:

> *"I once met one of the students at Pick n' Pay and asked her why she is no longer coming to our cafeteria and she said 1; things at your cafeteria are expensive, 2; they are not tasty, 3; there is no variety but at Pick n' Pay there is a lot of variety."*

This often led to food waste at the service point, especially during lunch times (unbooked service), due to fewer students coming for lunch than forecasted. Comparing the findings with those of other studies, confirms that competitors have an influence on food waste generation. Specifically, Heikkilä *et al.* (2016) indicated that the content and appeal of a competitors' menu makes it difficult to accurately forecast the amount of food to produce, resulting in waste generated during service.

- *Student demographics*

Generally, female students generated more food waste than males (FG, O). It was observed that female students often requested smaller portions than the standardised portion sizes, which ended up being unconsumed. The findings are in accordance with similar studies (Nozue, Yoshita, Jun, Ishihara, Taketa, Naruse, Nagai & Ishida., 2010; Painter *et al*., 2016) indicating that more food waste was produced by females than males as females tend to consume less food than males. On some occasions, food waste occurred as a result of inconsistent and oversized portions offered to male students, who perceived standardised portions as too little (FG, O). As discussed under distribution and service (Section 5.2.2.2), serving large portion sizes was a waste, as this resulted in selling fewer servings than intended, hence monetary loss. The literature (Painter *et al*., 2016) shows that male students consumed oversized portions and often went for second helpings but did not view this as waste. This indicates that the current literature on food waste in food service operations narrowly views food waste on the basis of the amount of waste generated and overlooks the monetary loss associated with waste.

Contrary to the above general observation, the study further revealed that with regards to vegetables, males generated more waste than females (I, O). This was because most males chose not to have vegetables or salads and this became waste. A possible explanation for this is that females tend to be more health conscious than males, hence consuming more vegetables (hence less waste) in an attempt to maintain good health and body image.

- *Students' lifestyle*

Students' busy lifestyle was associated with food waste generation linked to missing meals, hence waste. This has been elaborately discussed in Section 5.2.1.4.

- *Weather*

Irregular demand and difficulties in predicting demand accurately, due to weather variations, was a contributing factor in food waste generation at the University food service unit. The food service workers indicated that during cold and rainy days, the number of students fluctuated, which led to food waste. A similar observation was made by Prescott *et al.* (2019), who indicated that during cold weather, the number of customers fluctuated and a substantial amount of food waste was created. In this study, substantial food waste, due to cold weather, was experienced during the breakfast service (FG, O). In order to curb the waste, the food service unit ended up adopting a booking system for breakfast, as well as using unconsumed breakfast menu items, to make sandwiches for sale at the University convenience store.

In the next subsection, internal environmental forces that contributed to food waste at the University food service unit, are discussed.

5.2.7.2 Internal environmental factors

Internal environmental factors, such as technological failures, unskilled staff and University events, contributed to food waste generation. The following discussion explains how these factors contributed to food waste at the case University.

- *Technological failures*

Technical inefficiencies or failure at different stages of the food service system contributed to food waste generation. The interviewees highlighted technical failures of food storage equipment as a cause of food waste during food storage (I). As indicated in Section 5.2.2.1, the University food service unit cited a high waste of meat, which was wasted as result of the freezer being at an incorrect temperature due to a possible mechanical failure. Additionally, technical failures of the automated stock management system was often experienced. However, food waste as a result of this was not observed. This could be because the University food service unit switched to manual stock monitoring whenever the system was down.

- *Unskilled staff*

As discussed in Section 5.2.1.1, unskilled staff or food service workers, who lacked professional skills in food service, contributed to food waste generation in the different stages of the University food service system.

- *University events*

University activities and events such as sports events, tests and examinations were highlighted by some participants as factors creating food waste in the University food service system (FG,I). The lack of predictability of the number of customers as a result of such events led to overproduction of food, which ended up being disposed of (Charlebois *et al*., 2015).

The next section discusses food waste management practices followed by the case University food service system and the implications on environmental sustainability.

5.3 FOOD WASTE MANAGEMENT APPROACHES AND SUSTAINABILITY

The extent to which food waste was generated at the University food service unit has been discussed. How the food waste generated is managed is an important aspect with environmental sustainability implications. The food waste management practices followed by the University food service system were represented by the food waste hierarchy in Figure 5.36. This is adapted from the five-tier formulation of the hierarchy formalised by the Waste Framework Directive which was adopted by the European Commission (Filimonau & De Coteau, 2019; Mourad, 2016). The food waste hierarchy indicates the waste management options adopted by the University food service unit as discussed below.

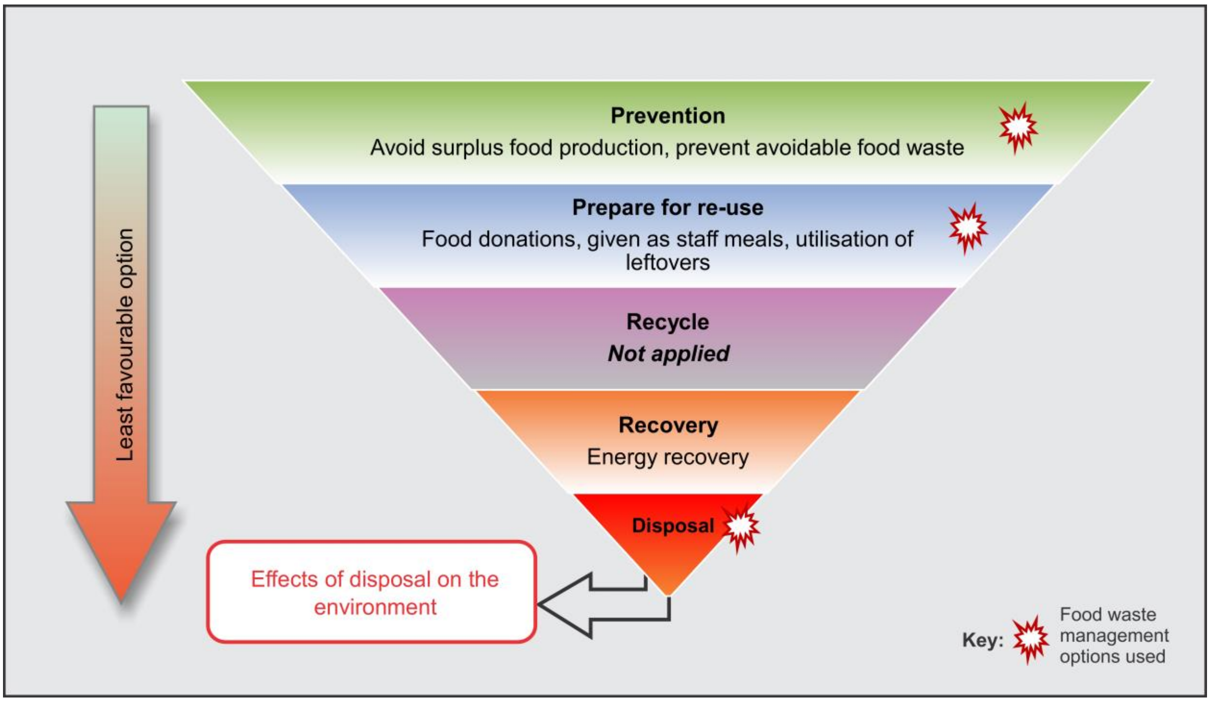


FIGURE 5.36: THE UNIVERSITY FOOD SERVICE SYSTEM'S FOOD WASTE MANAGEMENT APPROACH

5.3.1 Prevention

The findings of the study showed that a considerable amount of food waste was generated at the University food service unit. However, food waste prevention strategies were implemented to avoid food waste occurring in the first place. A detailed discussion on food waste prevention strategies applied by the case University food service unit is covered in Chapter 6. As indicated by numerous literature sources (Dou *et al*., 2016; Garcia-Garcia *et al*., 2015; Mourad, 2016; Papargyropoulou *et al*., 2014; Priefer *et al*., 2016), the prevention of food waste benefits the environment and is the most sustainable food waste management option.

5.3.2 Re-use

Where there was leftover food, it was re-used. Specifically, surplus food suitable for human consumption was distributed to the orphanages to feed the children (I, O). In this way, food security was improved and the environment conserved (Garcia-Garcia *et al*., 2015; Papargyropoulou *et al*., 2014). However, the distribution of food from the University food service unit to the orphanages might have added to the carbon footprint, due to the carbon emissions from the distribution vehicles. The participants of the study highlighted that the food safety standards and regulations against the redistribution of leftover food, impeded the donation of excess food. This often led to disposal of food that could have been redistributed (I, O).

Other ways in which the University food service unit managed food waste was to distribute unsold food to staff. Additionally, some leftovers were used in the creation of other menu items, for example, eggs left over from breakfast were used to make sandwiches (O, I, FG). Nonetheless, food items that were distributed at a time when quality was lost, still ended up being discarded (O, I).

5.3.3 Recycle

The application of this approach at the University food service unit was not feasible. Specifically, composting food waste was hampered by space constraints. During the preliminary study, the Manager of General Waste and Environmental Management, within the Department of Facilities Management at the University of Pretoria, indicated that the lack of space and the high initial investment costs hampered composting of food waste. Recycling through diverting food waste to animal feeding with the intention to protect animals, was also not possible. Food waste typically contains meat waste and if not treated, can transmit diseases, such as foot-and-mouth and African swine fever to animals (Salamdeeb *et al*., 2014; Zhang *et al*., 2014).

5.3.4 Recovery

The diversion of food waste from landfills to other beneficial non-human use was done to a very limited extent. Recycling was only limited to used cooking oil (UCO) (Figure 5.37 – next page) which was collected and sold to authorised companies that convert the cooking oil into biodiesel for energy recovery (O, I). Assessment of the environmental sustainability of conversion of UCO to biodiesel was beyond the scope of this thesis. However, the literature generally shows that the collection stage (collection from restaurants to recycling industries) contributed the most to CO_2 emissions generated in the biodiesel production process (Moecke, Feller, Dos Santos, De Medeiros Machado, Cubas, De Aguiar Dutra & Soares, 2016).

5.3.5 Disposal

The largest amount of food waste generated at the University food service unit, was discarded and disposed of at the municipal landfills (O, I). Sending food waste to landfills or incineration, is the least preferred management option with the most negative environmental impact, yet the most adopted method in the food service sector (Thi *et al*., 2015). The disposal of food waste at landfills by the University food service unit, possibly had negative environmental impacts, including groundwater pollution by leaching, and the emission of toxic and greenhouse gases (Ren *et al*., 2018; Thi *et al*., 2015).

FIGURE 5.37: USED COOKING OIL COLLECTED FOR RECYCLING

5.4 SUMMARY

To prevent food waste and achieve more sustainable food systems, it is imperative to understand the causes of food waste from a holistic perspective. The study conducted a comprehensive investigation of the causes of food waste in all areas of the University food service system. This chapter has thus contributed to the limited literature in this context and the theoretical perspective. An understanding of food waste from the systems perspective is useful in developing strategies that adequately address food waste in the entire food service system. In line with this, the next chapter focuses on the development of a tool to address food waste in the University food service system.

Chapter 6:

THE DEVELOPMENT OF A TOOL TO ADDRESS FOOD WASTE

Chapter 6

THE DEVELOPMENT OF A TOOL TO ADDRESS FOOD WASTE

This chapter presents findings addressing the second objective; development of a total quality management tool, integrating sustainability practices to address food waste in the University food service system.

6.1 INTRODUCTION

The ultimate goal of this study was to develop a comprehensive tool of total quality management practices that integrates sustainability to prevent food waste in the University food service system. As indicated in Figure 6.1, the development of the tool began with a predevelopment phase in which a systematic review was undertaken. This was to conceptualise

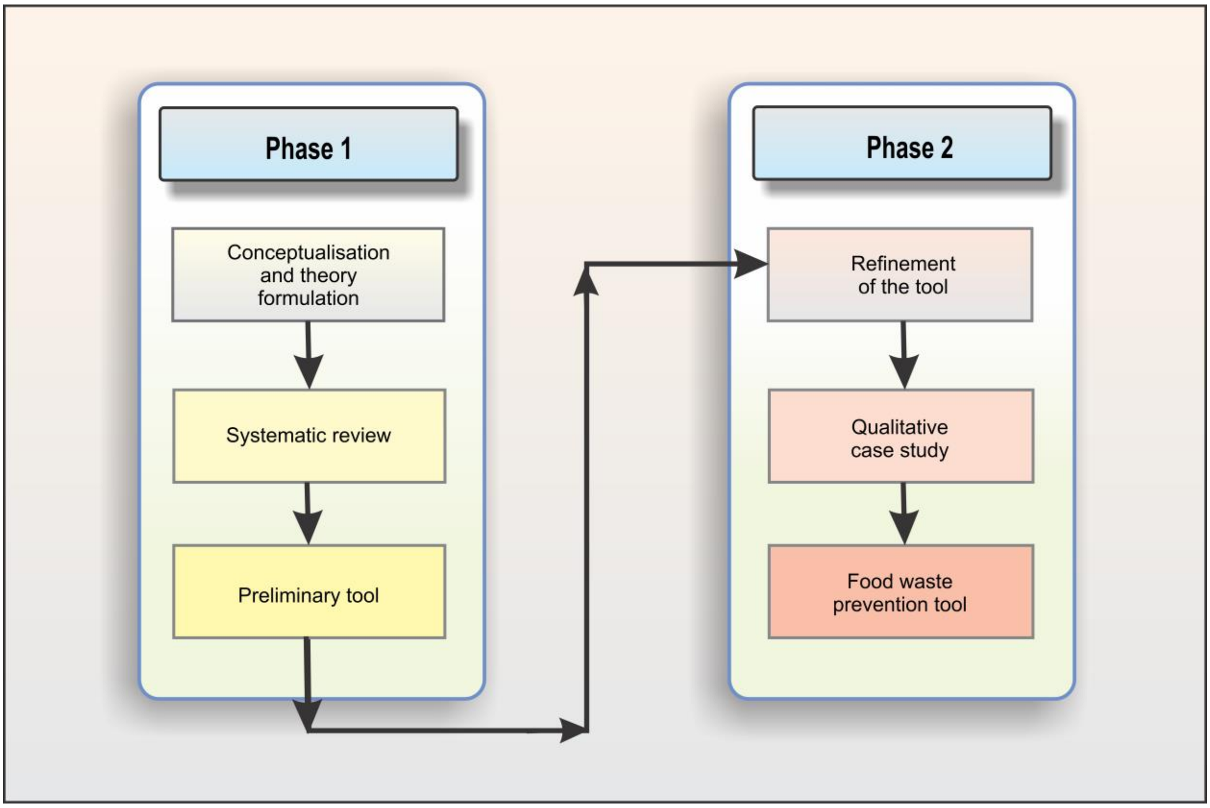


FIGURE 6.1: OVERVIEW OF THE TOOL DEVELOPMENT PROCESS

practices, with the potential to address food waste in food service units. The next phase being developmental, aimed at further refining the preliminary tool developed in the first phase. A qualitative case study approach was applied to gain a deeper understanding of the dimensions and indicators of total quality management and sustainability practices that addressed food waste in the specific context of the University food service operations. The tool developed was therefore, an integration of the findings from two sequential phases.

PHASE 1: FINDINGS OF THE PREDEVELOPMENT PHASE

The first activity conducted prior to the development of the tool to address food waste, was an in-depth, systematic review of the literature on total quality management and sustainability practices. These key constructs, their dimensions and indicators informed the preliminary development of the tool to address food waste. This section therefore, presents the dimensions and indicators of total quality management and sustainability practices, which were explored through a systematic review of the predevelopment phase.

6.2 TOTAL QUALITY MANAGEMENT (TQM) PRACTICES

The study analysed a total of 47 journal articles based on empirical evidence. The papers were published from 1991 to 2016 and are non-uniformly distributed in time, as shown in Figure 6.2. Of the papers reviewed, the majority (six) were published in the year 2015.

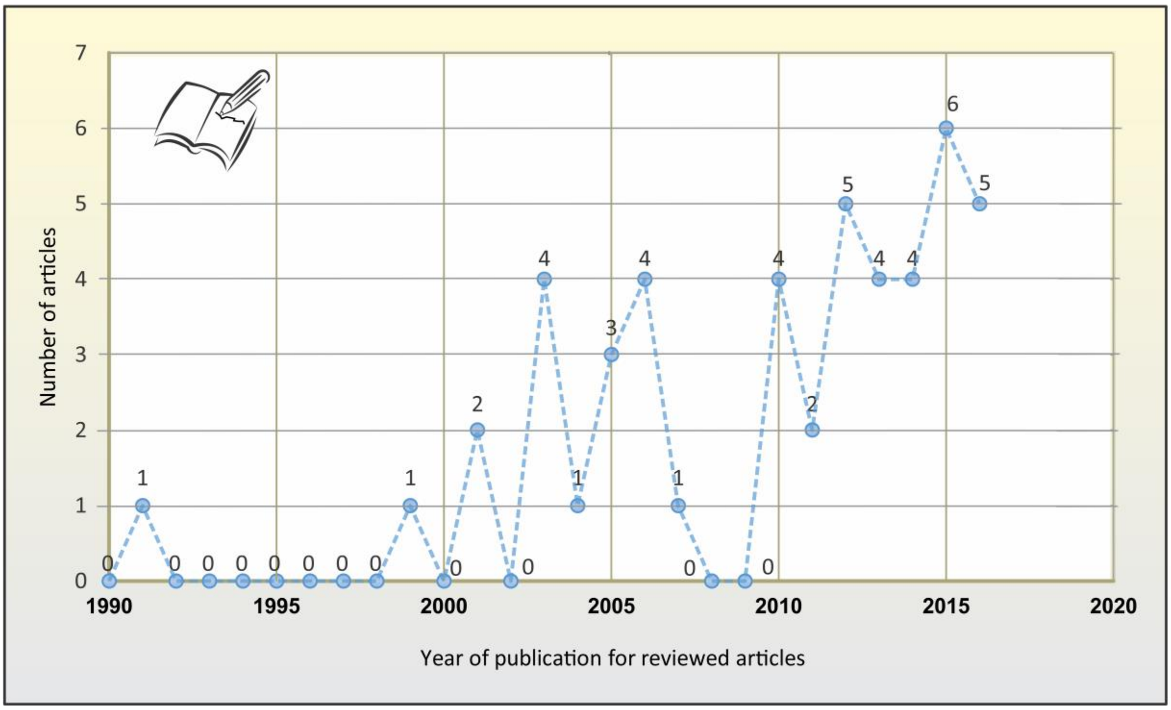


FIGURE 6.2: TEMPORAL DISTRIBUTION OF ARTICLES SELECTED FOR REVIEW

The literature matrix of the included articles is annexed in Addendum O. The papers reviewed were based on total quality management practices in the service industry. Research articles conducted in the manufacturing industry were excluded, given the differences of the nature of products and services offered in the manufacturing and service industries. However, those that covered both the manufacturing and service industry were included. The studies that were reviewed, focused on the industries indicated in Figure 6.3 below.

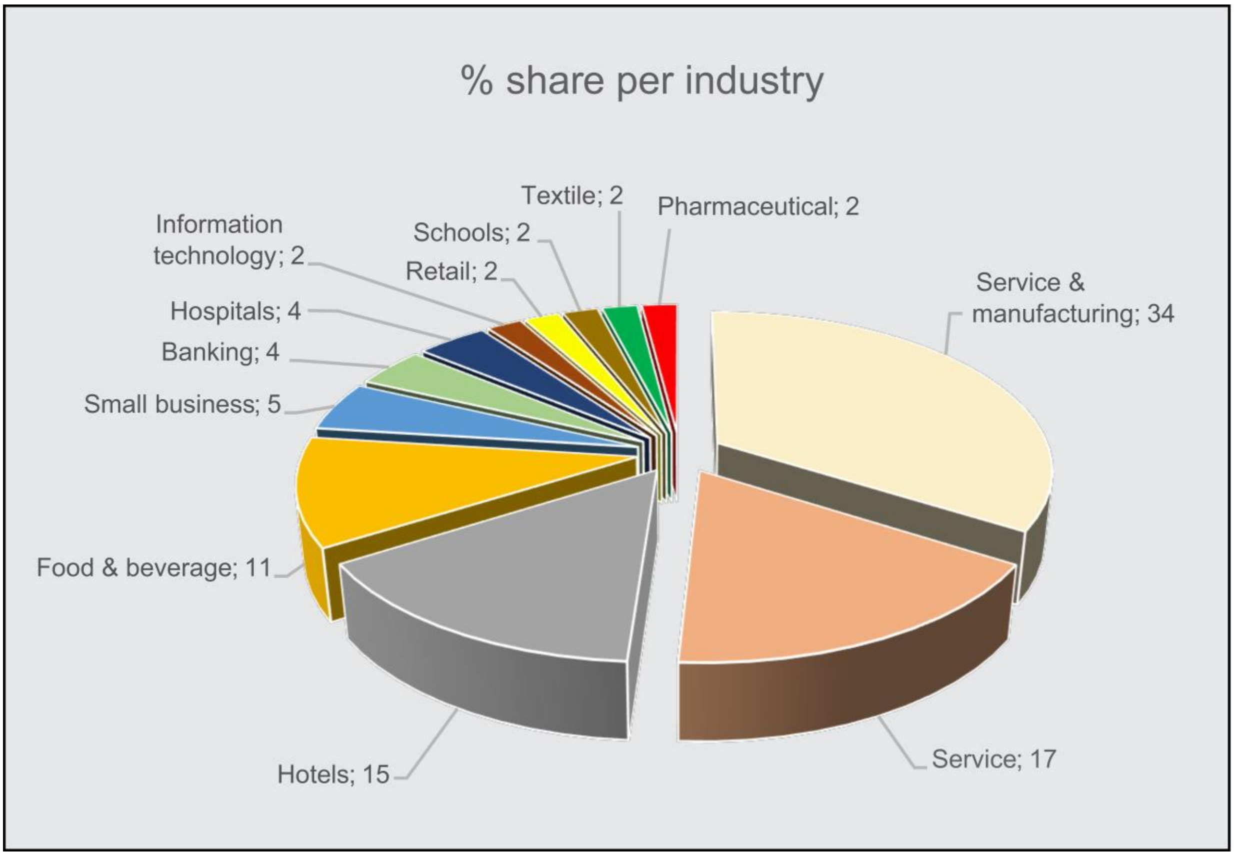


FIGURE 6.3: DISTRIBUTION OF PAPERS REVIEWED ACCORDING TO THE INDUSTRY STUDIED

As illustrated in Figure 6.3, most of the papers concentrated on multiple types of businesses in both the service and manufacturing industries (34%), followed by the service industry only (17%) and the hospitality industry (hotels) – 15%. The food and beverage industry represented 11% of the reviewed papers but none considered the food service or catering operations. This exemplifies a gap in the literature on total quality management practices in the context of food service operations. The current study therefore, closes the gap and contributes to the literature in this regard.

6.2.1 Common dimensions of TQM

A total number of 24 dimensions of total quality management were identified from the dataset. The number of occurrences of the dimensions of TQM from the literature is tabulated in Table 6.1 below.

TABLE 6.1: TOTAL NUMBER OF OCCURRENCES OF TQM DIMENSIONS FROM THE LITERATURE

TQM Dimensions	Total number of occurrences n=47	Rank	Sources
1) Benchmarking	8	9	Behara & Gundersen, 2001; Dabestani, Taghavi & Saljoughian, 2014; Hasan & Kerr, 2003; Kahreh, Shirmohammadi & Kahreh, 2014; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013; Zhong, Ma, Tu & Li, 2016
2) Continuous improvement	6	12	Al-Ababneh & Lockwood, 2012; Karia & Asaari, 2006; Psomas *et al*., 2014; Singh, 2015; Talib *et al*., 2011; Talib *et al*., 2012
3) Customer focus / Customer satisfaction / Customer orientation	38	2	Al-Ababneh & Lockwood, 2012; Anderson & Sohal, 1999; Bou & Beltrán, 2005; Cetindere, Duran & Yetisen, 2015; Dabestani *et al*., 2014; Fotopoulos & Psomas, 2010; Fuentes *et al*., 2006; Hasan & Kerr, 2003; Hoang, Igel & Laosirihongthong, 2006; Jaca & Psomas, 2015; Jaeger & Adair, 2016; Kaluarachchi, 2010; Karia & Asaari, 2006; Kim *et al*., 2012; Krittanathip, Rakkarn, Cha-um & Konkhum, 2013; Li *et al*., 2003; Mosadeghrad, 2015; Munizu, 2013; Nair & Choudhary, 2016; Prajogo & Sohal, 2003; Psomas & Fotopoulos, 2010; Psomas & Jaca, 2016; Psomas, Vouzas & Kafetzopoulos, 2014; Sadikoglu & Olcay, 2014; Sadikoglu & Zehir, 2010; Sila & Ebrahimpour, 2004; Singh, 2015; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013;Talib *et al*., 2013[b]; Tarí, 2005; Tarí *et al*., 2007; Temtime, 2003; Tsang & Antony, 2001; Wang, Chen & Chen., 2012; Zehir & Sadikoglu, 2012; Zhong *et al.*, 2016

continues …

TQM Dimensions	Total number of occurrences n=47	Rank	Sources
4) Employee knowledge and education / Training and education	30	5	Al-Ababneh & Lockwood, 2012; Behara & Gundersen, 2001; Benson, Saraph & Schroeder, 1991; Cetindere *et al*., 2015; Dabestani *et al*., 2014; Fuentes, Montes & Fernández, 2006; Hasan & Kerr, 2003; Hoang *et al*., 2006; Jaca & Psomas, 2015; Kaluarachchi, 2010; Karia & Asaari, 2006; Ketikidis, Koh, Gunasekaran, Demirbag, Tatoglu, Tekinkus & Zaim, 2006; Kim *et al*., 2012; Li *et al*., 2003; Mosadeghrad, 2015; Muturi, Ho, Douglas, Nawelwa, Sichinsambwe & Mwanza, 2015; Nair & Choudhary, 2016; Psomas & Jaca, 2016; Sadikoglu & Olcay, 2014; Sadikoglu & Zehir, 2010; Singh, 2015; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013[b]; Tarí, 2005; Tarí *et al*., 2007; Tsang & Antony, 2001; Wang *et al*., 2012; Zehir & Sadikoglu, 2012; Zhong *et al*., 2016
5) Employee management and involvement / employee involvement / employee commitment and involvement / Employee relations / Human resource management / People management	36	3	Anderson & Sohal, 1999; Al-Ababneh & Lockwood, 2012; Behara & Gundersen, 2001; Benson *et al*., 1991; Cetindere *et al*., 2015; Dabestani *et al*., 2014; Fotopoulos & Psomas, 2010; Fuentes *et al*., 2006; Hasan & Kerr, 2003; Hoang *et al*., 2006; Jaca & Psomas, 2015; Jaeger & Adair, 2016; Kaluarachchi, 2010; Ketikidis *et al*., 2006; Kim *et al*., 2012; Krittanathip *et al.*, 2013; Mosadeghrad, 2015; Munizu, 2013; Nair & Choudhary, 2016; Psomas & Fotopoulos, 2010; Prajogo & McDermott, 2005; Psomas *et al.*, 2014; Psomas & Jaca, 2016; Psomas *et al*., 2014; Sila & Ebrahimpour, 2004; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013; Talib *et al*., 2013[b]; Tarí, 2005; Tarí *et al*., 2007; Temtime, 2003; Tsang & Antony, 2001; Wang *et al*., 2012; Zehir & Sadikoglu, 2012; Zhong *et al*., 2016
6) Quality Department	2	16	Al-Ababneh & Lockwood, 2012; Benson *et al*., 1991
7) Organisational culture / quality culture / service culture	8	9	Hoang *et al*., 2006; Kaluarachchi, 2010; Mosadeghrad, 2015; Muturi *et al*., 2015; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013[b]; Temtime, 2003
8) Process and product quality design	9	8	Al-Ababneh & Lockwood, 2012; Anderson & Sohal, 1999; Baird *et al*., 2011; Benson *et al*., 1991; Kim *et al*., 2012; Li *et al*., 2003; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013[b]

continues …

TQM Dimensions	Total number of occurrences n=47	Rank	Sources
9) Process quality management / process management	32	4	Al-Ababneh & Lockwood, 2012; Baird *et al*., 2011; Behara & Gundersen, 2001; Benson *et al*., 1991; Bou & Beltrán, 2005; Dabestani *et al*., 2014; Fuentes *et al*., 2006; Hoang *et al*., 2006; Jaca & Psomas, 2015; Ketikidis *et al*., 2006; Kim *et al*., 2012; Li *et al*., 2003; Mosadeghrad, 2015; Munizu, 2013; Nair & Choudhary, 2016; Prajogo & McDermott, 2005; Prajogo & Sohal, 2003; Psomas & Fotopoulos, 2010; Psomas & Jaca, 2016; Psomas *et al*., 2014; Sadikoglu & Olcay, 2014; Sadikoglu & Zehir, 2010; Sila & Ebrahimpour, 2004; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013; Talib *et al*., 2013[b]; Tarí, 2005; Tarí *et al*., 2007; Wang *et al*., 2012; Zehir & Sadikoglu, 2012; Zhong *et al*., 2016
10) Quality audit and evaluation / quality measurement	5	13	Behara & Gundersen, 2001; Li *et al*., 2003; Tarí, 2007; Temtime, 2003; Tsang & Antony, 2001
11) Quality data and reporting / information and analysis / data quality management	24	7	Al-Ababneh & Lockwood, 2012; Anderson & Sohal, 1999; Baird *et al*., 2011; Benson *et al*., 1991; Fotopoulos & Psomas, 2010; Hoang *et al*., 2006; Kaluarachchi, 2010; Ketikidis *et al*., 2006; Kim *et al*., 2012; Krittanathip *et al*., 2013; Modgil & Sharma, 2016; Mosadeghrad, 2015; Munizu, 2013; Nair & Choudhary, 2016; Prajogo & McDermott, 2005; Prajogo & Sohal, 2003; Psomas & Fotopoulos, 2010; Psomas *et al*., 2014; Sila & Ebrahimpour, 2004; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013; Talib *et al*., 2013[b]; Zehir & Sadikoglu, 2012;
12) Quality practices of top management / top management commitment / top management commitment and leadership / leadership	41	1	Al-Ababneh & Lockwood, 2012; Anderson & Sohal, 1999; Benson *et al*., 1991; Cetindere *et al*., 2015; Dabestani *et al*., 2014; Fotopoulos & Psomas, 2010; Fuentes *et al*., 2006; Hasan & Kerr, 2003; Hoang *et al*., 2006; Jaca & Psomas, 2015; Jaeger & Adair, 2016; Kaluarachchi, 2010; Ketikidis *et al*., 2006; Kim *et al*., 2012; Krittanathip *et al*., 2013; Li *et al*., 2003; Mosadeghrad, 2015; Munizu, 2013; Muturi *et al*., 2015; Nair & Choudhary, 2016; Prajogo & McDermott, 2005; Prajogo & Sohal, 2003; Psomas & Fotopoulos, 2010; Psomas & Jaca, 2016; Psomas *et al*., 2014; Sadikoglu & Olcay, 2014; Sadikoglu & Zehir, 2010; Sila & Ebrahimpour, 2004; Singh, 2015; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013; Talib *et al*., 2013[b]; Tarí, 2005; Tarí *et al*., 2007; Temtime, 2003; Tsang & Antony, 2001; Topalović, 2015; Wang *et al*., 2012; Zehir & Sadikoglu, 2012; Zhong *et al*., 2016

continues …

TQM Dimensions	Total number of occurrences n=47	Rank	Sources
13) Supplier collaboration / supplier quality management / supplier relations	26	6	Al-Ababneh & Lockwood, 2012; Baird *et al*., 2011; Benson *et al*., 1991; Dabestani *et al*., 2014; Hasan & Kerr, 2003; Kahreh *et al*., 2014; Ketikidis *et al*., 2006; Kim *et al*., 2012; Krittanathip *et al*., 2013; Li *et al*., 2003; Mosadeghrad, 2015; Nair & Choudhary, 2016; Psomas *et al*., 2014; Sadikoglu & Olcay, 2014; Sadikoglu & Zehir, 2010; Sila & Ebrahimpour, 2004; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013; Talib *et al*., 2013[b]; Tarí, 2005; Tarí *et al*., 2007; Temtime, 2003; Tsang & Antony, 2001; Zehir & Sadikoglu, 2012; Zhong *et al*., 2016
14) Teamwork	7	11	Behara & Gundersen, 2001; Dabestani *et al*., 2014; Fuentes *et al*., 2006; Muturi *et al*., 2015; Singh, 2015; Talib *et al*., 2012; Talib *et al*., 2013[b]
15) Compensation	1	20	Behara & Gundersen, 2001
16) Technology management	2	16	Behara & Gundersen, 2001; Modgil & Sharma, 2016
17) Communication	4	15	Dabestani *et al*., 2014; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013[b]
18) Get things right first time	1	20	Dabestani *et al*., 2014
19) Quality tools and techniques	5	13	Fotopoulos & Psomas, 2010; Hasan & Kerr, 2003; Talib *et al*., 2011; Talib *et al*., 2012; Talib *et al*., 2013[b]
20) Quality policy	2	16	Ketikidis *et al*., 2006; Tsang & Antony, 2001
21) Safety, health and environment	2	16	Krittanathip *et al*., 2013; Zhong *et al*., 2016
22) Product innovation	1	20	Modgil & Sharma, 2016
23) Resource management	1	20	Mosadeghrad, 2015
24) Quality assurance	1	20	Talib *et al*., 2013

The review of the literature on total quality management practices yielded **eight dimensions** that were frequently cited, and these are, in the order of the most frequently cited:

1. Quality practices of top management;

2. Customer focus;

3. Employee management and involvement;

4. Process quality management;

5. Employee knowledge and education;

6. Supplier quality management;

7. Information and analysis; and

8. Process and product quality design.

The next section presents the findings of the review on the indicators of the dimensions of total quality management practices.

6.2.2 Indicators of TQM practices

This part of the study describes the dimensions of total quality management practices. Indicators of the dimensions of TQM practices were also identified, as presented in Table 6.2 (next page). This exercise generated a total of **41 indicators** of TQM practices.

TABLE 6.2: INDICATORS OF TOTAL QUALITY MANAGEMENT PRACTICES

TQM Practices	Description	Indicators of TQM practices	References
Quality practices of top management	This construct describes the crucial role played by top management with the implementation of TQM (Jung & Wang, 2006). When top management is fully committed, they provide the necessary resources, organise processes and activities, and remove barriers to enable the successful implementation of TQM practices (Mosadeghrad, 2014).	- Management actively participates in quality management efforts. - Management holds regular meetings to discuss quality related issues. - Management supports quality improvement efforts by providing the necessary resources. - The quality policy is taken into consideration in strategic planning. - Quality data is taken into consideration in decision-making. - The quality policy is communicated throughout the company. - Top management gives employees the authority to manage quality problems. - Management sets quality strategies for employees. - Quality results are evaluated to check improvements. - Management gives priority to production processes.	Bouranta *et al*., 2017; Jaca & Psomas, 2015; Li *et al*., 2003; Psomas & Fotopoulos, 2010; Qasrawi *et al*., 2017; Sadikoglu & Olcay, 2014; Tari *et al*., 2007.

continues …

TQM Practices	Description	Indicators of TQM practices	References
Customer focus	Refers to the extent to which an organisation seeks to understand its customers' needs to produce and deliver products and services that fulfill or even exceed customers' expectations (Kim *et al*., 2012; Sureshchandar *et al*., 2010).	- There is a documented process of collecting customer feedback. - Customers are encouraged to submit complaints and proposals for quality improvement. - Customer complaints and proposals for quality improvement are selected. - The organisation's managers and employees are in close contact with the customers. - Customers' needs, requirements and desires are recorded and analysed.	Bouranta *et al*., 2017; Jaca & Psomas, 2015; Li *et al*., 2003; Nawelwa et al., 2015; Psomas & Fotopoulos, 2010; Qasrawi *et al*., 2017; Sadikoglu & Olcay, 2014; Talib *et al*., 2013; Tari *et al*., 2007.
Employee management and involvement	Refers to the extent to which employees are involved in quality efforts and encouraged to participate in quality decisions, have a responsibility to the provision of quality products and services (Kim *et al*., 2012; Rahman, 2001).	- Employees, who improve quality, are rewarded. - Employees are evaluated. - Employees participate in quality improvement activities. - Employees take initiatives. - Employees recognise superior quality performance. - Employees are motivated to improve their performance.	Bouranta *et al*., 2017; Jaca & Psomas, 2015; Li *et al*., 2003; Psomas & Fotopoulos, 2010; Quazi *et al*., 2002; Rahman, 2001; Sadikoglu & Olcay, 2014; Tari *et al*., 2007.

continues …

TQM Practices	Description	Indicators of TQM practices	References
Process quality management	Process quality management emphasises taking a preventative and proactive approach to improving the quality, which entails designing processes that are fool-proof (Kaynak, 2003; Sadikoglu & Zehir, 2010).	- Process non-conformities are detected through internal audits. - Critical processes are determined and evaluated. - Determination of areas, processes and points for improvement. - Specific organisational structures have been formulated to support quality improvement. - All employees are provided with instructions. - Mistakes are precluded in the process design. - Setting ranges within which non-conformities are allowed.	Jaca & Psomas, 2015; Kaynak, 2003; Psomas *et al*., 2017; Sadikoglu & Olcay, 2014.
Employee knowledge and education	Deals with how well employees are capacitated or trained to execute their work and quality related practices (Li *et al*., 2003; Talib *et al*., 2013).	- Educational programmes are evaluated. - Employees are trained on topics with regard to their specialty and daily work. - Employees have knowledge and know-how. - Employees are educated in quality management techniques. - Resources are provided for staff training.	Bouranta *et al*., 2017; Jaca & Psomas, 2015; Psomas *et al*., 2017.

continues …

TQM Practices	Description	Indicators of TQM practices	References
Supplier quality management	Supplier quality management refers to the extent to which an organisation depends on its suppliers, is interdependent with suppliers, and works together with them to continuously improve the quality (Kim *et al*., 2012).	- There is a solid partnership with suppliers. - The specifications are clearly determined by the organisation to the suppliers. - The organisation's representatives implement quality audits at the suppliers' site. - Suppliers are selected on quality rather than price or schedule.	Kim *et al*., 2012; Li *et al*., 2003; Psomas *et al*., 2017; Talib *et al*., 2013.
Information and analysis	This dimension refers to the systematic recording and analysis of organisational data (Psomas & Fotopoulos, 2010).	- A variety of data collection methods are used to ensure the reliability of quality performance data. - There is adequate storage for archiving of the information. - Easy retrieval of stored information - Systematic analysis of data.	Anil & Satish, 2015; Fening *et al*., 2008; Kaynak, 2003, Quazi *et al*., 2002; Rahman, 2001; Sadikoglu & Zahir, 2010.

continues …

TQM Practices	Description	Indicators of TQM practices	References
Process and product quality design	Process and product quality design refers to the extent to which an organisation performs activities and processes geared to producing and delivering good quality products and services (Talib *et al*., 2013). This dimension involves the unique combination of production and supporting processes meant to produce quality products and services (Li *et al*., 2002).	**Explored through qualitative data collection methods (phase 2).*	

The next section reports the findings of the review of the impact of total quality management on business results or organisational outputs, including the generation of waste.

6.2.3 The impact of TQM practices on organisational outputs

As discussed in Chapter 3, Section 3.4.6, the literature provides theoretical and empirical evidence of the positive impact of total quality management practices on organisational outputs. According to researchers in the field, the adoption of TQM practices positively influences numerous dimensions of organisational performance, including the quality of products and reduced costs (Agus & Hassan, 2011; Kaynak, 2003; Patiar *et al*., 2012; Sadikoglu & Olcay, 2014; Topalović, 2015). Moreover, researchers have confirmed that the implementation of TQM practices influences innovation performance (Prajogo & Sohal, 2003; Kim *et al*., 2012), as well as customer satisfaction (Kristianto *et al*., 2012; Mehra & Ranganathan, 2008; Topalović, 2015).

The limited literature available shows that TQM's impact on waste generation has been investigated in other contexts but to a lesser extent in the catering sector. Askarian *et al*. (2010) applied a total quality management approach to healthcare waste management in an Iranian hospital. The results of this study indicated a 26% reduction in medical waste after the implementation of the TQM approach to waste management (Askarian *et al*., 2010). Generally, empirical findings support the proposition that TQM is positively linked to the reduction of overall waste, by preventing errors and eliminating the need for inspection, thus reducing the need for the reproduction of products (Rawlins, 2008). Given the current lack of information on the influence of TQM practices on food waste in the specific context of food service operations, the study further investigated this issue using a qualitative research approach (case study); the findings will be discussed in Section 6.5 of this chapter.

Based on the findings of the systematic review of the literature, the following conceptual framework, illustrating the influence of total quality management practices on organisational outputs or business results, is presented in Figure 6.4 (next page).

The model illustrates that the implementation of TQM practices has an impact on the organisational outputs, including improved quality, customer satisfaction, reduced costs, innovative performance and reduced waste. However, there is no empirical evidence from the literature of the influence of total quality management practices on the generation of food waste in food service operations. The subsequent sections address this gap in the literature.

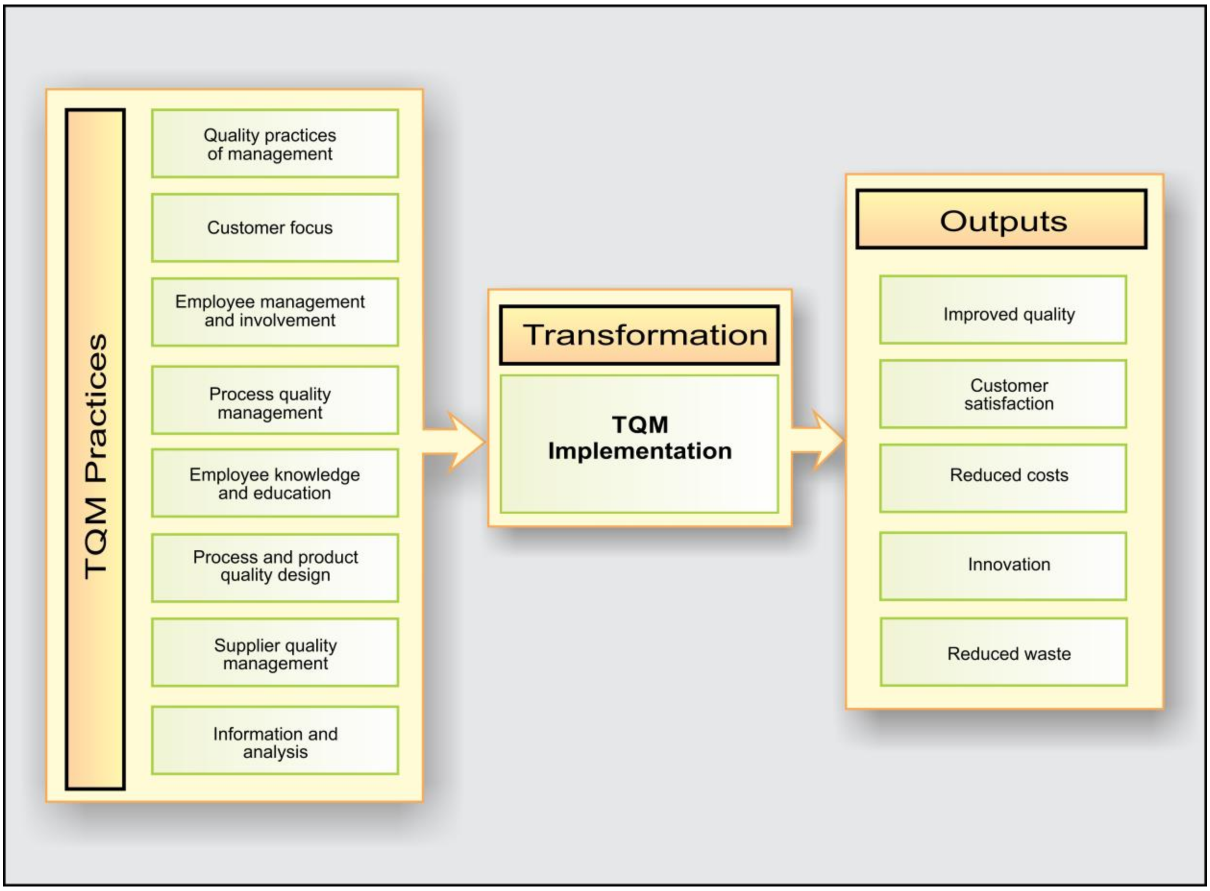


FIGURE 6.4: CONCEPTUAL MODEL OF THE IMPACT OF TQM PRACTICES ON OUTPUTS

Another aspect addressed through a systematic review of the literature, was the identification of the dimensions and indicators of sustainability that could be applied to address food waste in food service operations. The next section presents the findings in this component.

6.3 SUSTAINABILITY PRACTICES

This section discusses the characteristics of the studies reviewed under the construct of sustainability practices. The dimensions of sustainability and their indicators were identified and discussed.

6.3.1 General overview of publications by year and country of publication

A total of 27 empirical papers with relevance to sustainability practices in food service operations, were reviewed. As indicated in Figure 6.5, in the years before 2007, no research

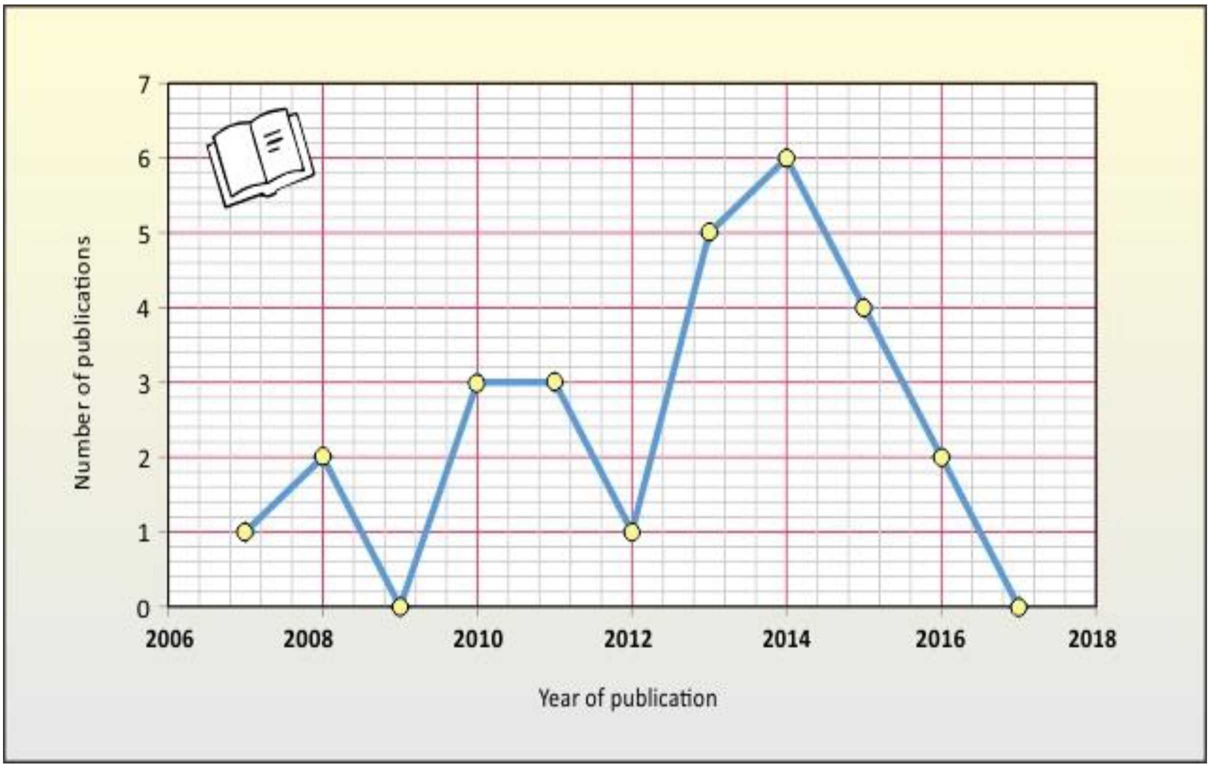


FIGURE 6.5: DISTRIBUTION OF ARTICLES BY YEAR OF PUBLICATION

articles were found that focused on sustainability or green practices in food service operations. In 2007, only one paper was published in this field. The highest number of publications in one year was in 2014 with six research articles. Overall, the number of publications addressing sustainability practices in food service operations or restaurants, illustrates an unbalanced trend over time. This indicates that generally, there is a growing awareness of sustainability problems in the food service industry, which attracts scholars to investigate the issues. An upward trend to research this topic can be anticipated, given the increase in interest of the issue of sustainability across the globe.

Furthermore, the reviewed articles came from 11 countries, which are summarised in Figure 6.6 (next page). The United States of America took the lead with a total number of 16 articles, focusing solely on sustainability practices in food service operations located in the country. Taiwan was the second highest with four published articles.

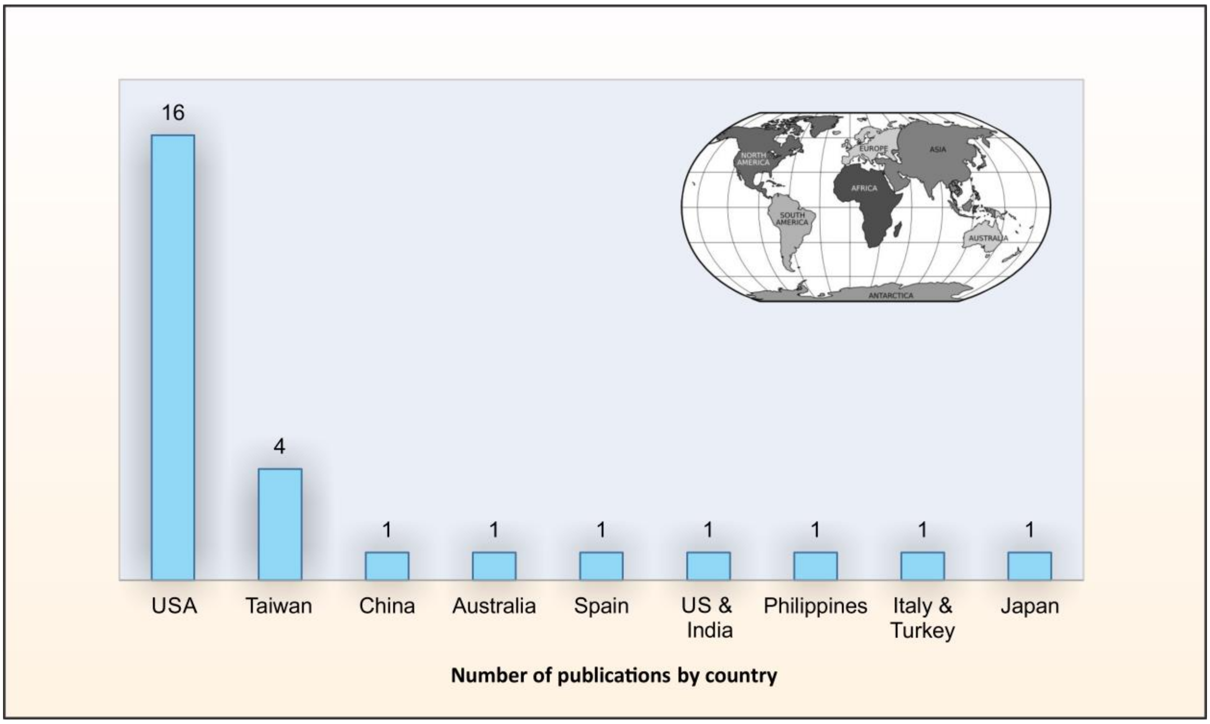


FIGURE 6.6: DISTRIBUTION OF ARTICLES BY COUNTRY OF SIMILAR STUDIES

6.3.2 Dimensions and indicators of sustainability practices in food service operations

In order to develop the classification framework and identify indicators of sustainability in the context of food service operations, each journal article was carefully reviewed and analysed. The findings of the reviews are shown in Addendum P. Generally, sustainability practices implemented in the food service sector, predominantly focus on the environmental dimension. A few practices that were implemented, fell within the social sustainability dimension. Table 6.3 gives a summary of the dimensions and indicators of sustainability practices identified in the literature in the food service field.

A total number of 17 major sustainability practices were found in the existing literature. On the whole, 14 environmental sustainability practices, accounting for 82.4% of all identified sustainability practices, were implemented in food service operations. These practices were further categorised as environmental focused practices (seven identified) and food focused practices (seven identified). Social sustainability, on the other hand, received less focus in the food service sector. It was implemented through three major practices, holding 17.6% of all the practices identified.

TABLE 6.3: MAJOR SUSTAINABILITY PRACTICES IDENTIFIED FROM THE REVIEW

Sustainability dimensions	Sub-facets	Indicators	Percentage of occurrences	References
Environmental	*Environment focused practices*	Reduced food miles	11.1%	Fennell & Markwell, 2015; Frash *et al*., 2015; Namkung & Jang, 2013.
		Energy efficiency and conservation	70.4%	Baldwin *et al*., 2011; Choi & Parsa, 2007; Dewald, Bruin & Jang, 2014; Dogan, Nebioglu & Demirag, 2015; Dutta, Umashankar, Choi & Parsa, 2008; Hilario, 2014; Hu, Parsa & Self, 2010; Iaquinto, 2014; Jeong & Jang, 2010; Jeong, Jang, Day & Ha, 2014; Kim *et al*., 2013; Kwok, Huang & Hu, 2016; Ma & Ghiselli, 2016; Namkung & Jang, 2013; Perramon *et al*., 2014; Schubert, 2008; Schubert, Kandampully, Solnet & Kralj, 2010; Wang, 2012; Wang *et al*., 2013.
		Water efficiency and conservation	59.3%	Baldwin *et al*., 2011; Dewald *et al*., 2014; Dogan *et al*., 2015; Hilario, 2014; Hu *et al*., 2010; Iaquinto, 2014; Jeong & Jang, 2010; Jeong *et al*., 2014; Kim *et al*., 2013; Kwok *et al*., 2016; Ma & Ghiselli, 2016; Namkung & Jang, 2013; Perramon *et al*., 2014; Schubert, 2008; Wang, 2012; Wang *et al*., 2013.
		Recycling	59.3%	Choi & Parsa, 2007; Dewald *et al*., 2014; Dutta *et al*., 2008; Fennell & Markwell, 2015; Hilario, 2014; Hu *et al*., 2010; Huang *et al*., 2011; Iaquinto, 2014; Jang, Kim & Bonn (2011); Jeong & Jang, 2010; Jeong *et al*., 2014; Kim *et al*., 2013; Kwok *et al*., 2016;

continues …

Sustainability dimensions	Sub-facets	Indicators	Percentage of occurrences	References
				Namkung & Jang, 2013; Schubert, 2008; Wang, 2012.
		Recyclable or biodegradable take-out containers	40.7%	Huang *et al*., 2011; Jang *et al*., 2011; Jeong & Jang, 2010; Jeong *et al*., 2014; Kim *et al*., 2013; Kwok *et al*., 2016; Namkung & Jang, 2013; Schubert, 2008; Schubert *et al*., 2010; Wang, 2012; Wang *et al*., 2013.
		Using eco-friendly cleaning products	37%	Baldwin *et al*., 2011; DiPietro, Gregory & Jackson, 2013; DiPietro *et al*., 2013; Hu *et al*., 2010; Jeong & Jang, 2010; Kim *et al*., 2013; Perramon *et al*., 2014; Schubert, 2008; Wang, 2012; Wang *et al*., 2013.
		Composting	29.6%	Fennell & Markwell, 2015; Hu *et al*., 2010; Huang *et al*., 2011; Iaquinto, 2014; Kim *et al*., 2013; Kwok *et al*., 2016; Schubert, 2008; Wang, 2012.
	Food focused practices	Use of locally sourced ingredients	74.1%	Chen, Cheng & Hsu, 2015; Choi & Parsa, 2007; DiPietro *et al*., 2013; DiPietro *et al*., 2013; Dutta *et al*., 2008; Fennell & Markwell, 2015; Frash *et al*., 2015; Hilario, 2014; Hu *et al*., 2010; Huang *et al*., 2011; Iaquinto, 2014; Jeong & Jang, 2010; Kim *et al*., 2013; Kwok *et al*., 2016; Namkung & Jang, 2013; Pinard *et al*., 2014; Schubert, 2008; Schubert *et al*., 2010; Wang, 2012; Wang *et al*., 2013.
		Use of seasonal food	11.1%	Chen *et al*., 2015; Choi & Parsa, 2007; Wang *et al*., 2013.

continues …

Sustainability dimensions	Sub-facets	Indicators	Percentage of occurrences	References
		Use of organic food	66.7%	Chen *et al*., 2015; Choi & Parsa, 2007; DiPietro *et al*., 2013; DiPietro *et al*., 2013[b]; Fennell & Markwell, 2015; Hilario, 2014; Hu *et al*., 2010; Huang *et al*., 2011; Jang *et al*., 2011; Jeong & Jang, 2010; Kim *et al*., 2013; Kwok *et al*., 2016; Namkung & Jang, 2013; Pinard *et al*., 2014; Schubert, 2008; Schubert *et al*., 2010; Wang, 2012; Wang *et al*., 2013.
		Sustainably sourced food	33.3%	Baldwin *et al*., 2011; Chen *et al*., 2015; Dewald *et al*., 2014; Hilario, 2014; Hu *et al*., 2010; Namkung & Jang, 2013; Pinard *et al*., 2014; Wang, 2012; Wang *et al*., 2013.
		Animal welfare approved products	7.4%	Pinard *et al*., 2014; Wang *et al*., 2013.
		More plant-based items, less animal-based food	14.8%	Choi & Parsa, 2007; Hu *et al*., 2010; Schubert, 2008; Wang *et al*., 2013.
		Reduction of processed food	7.4%	Choi & Parsa, 2007; Wang *et al*., 2013.
Social	*Not applicable*	Involved in community activities	11.1%	Choi & Parsa, 2007; Kim *et al*., 2013; Kwok *et al*., 2016.
		Offer benefits to employees	11.1%	Choi & Parsa, 2007; Dutta *et al*., 2008.
		Contribute food to local charities	3.7%	Dutta *et al*., 2008.

6.3.3 Discussion of sustainability practices identified in the literature

An in-depth discussion of sustainability practices implemented in food service operations was covered in Chapter 3, Section 3.4. This part of the study provides an analytical discussion of sustainability practices in relation to the prevention of food waste in the food service sector, albeit there is little attention given to this area in the literature.

6.3.3.1 Environmental sustainability practices and food waste in food service operations

According to extant literature of restaurant management, sustainability practices used in food service operations can be classified into two types: environment-focused and food-focused (Namkung & Jang, 2013; Xu & Jeong, 2019; Wang *et al*., 2013). This section discusses sustainability practices that fall within these subfacets and considers how they contributed to the prevention of food waste.

- *Environment-focused practices and food waste*

These are practices that relate to equipment usage, water and energy consumption, transport logistics and the food service environment, which lower the environmental risk of food service operations and raise ecological efficiency. The literature reviewed for this study reported on environmentally focused practices adopted in the food service industry. As illustrated in Table 6.3, the most frequently mentioned practice was energy efficiency and conservation (70.4%). The implementation of this practice in the food service sector, include; using energy efficient kitchen equipment and appliances, controlling the heating, ventilation and air conditioning (HVAC) systems, switching off cooking hoods and equipment when not in use, batch cooking and the adoption of less energy consumption cooking methods (Baldwin *et al*., 2011, Lewis *et al*., 2011, Vu *et al*., 2017; Wang *et al*., 2013). Previous research has not explored the potential of energy conservation measures on reducing food waste.

Another indicator, water efficiency and conservation that had been measured, were found in 59.3% of the reviewed articles. Water efficient practices include examples, such as the installation of water efficient fixtures and equipment, like low-flow fixtures, spray nozzles, the replacement of existing water-intensive equipment with improved water efficient models, as well as turning off taps when not in use (EPA, 2012; Peregrin, 2011; Wang *et al*., 2013). From the current literature, it could not be established if there is a relationship between water efficient practices and the reduction in the generation of food waste. More than half (59.3%)

of the studies reviewed adopted recycling practices. The most commonly recycled materials included oil (converted into biofuel), and cardboard, paper and plastic (Dutta *et al*., 2008; Huang *et al*., 2011; Jeong *et al*., 2010). With reference to the waste hierarchy, recycling is less preferable compared to preventing waste, thus falls out of the scope of this study. Of the studies reviewed, 40.7% reported the use of recyclable or biodegradable take-out containers, 37% mentioned the use of eco-friendly cleaning materials and 29.6% reported the adoption of composting in food service organisations. These practices have not previously been related to the prevention of food waste in the reviewed literature.

Few of the studies reviewed (11.1%) reported reduced food miles as an important aspect of sustainable food provision. According to Macdiamird (2013), short supply chains often have a reduced impact on the environment. Several scholars argued that food mileage has an important bearing on the generation or prevention of food waste. From the literature, it was found that food purchased and transported over a short distance, retains food quality better than over long distances (Frash *et al*., 2015; Pearson *et al*., 2011). This means that food sourced from within reduced food miles may therefore, contribute to preventing food waste.

- *Food-focused practices and food waste*

Food-focused sustainable practices refer to the procurement and use of sustainable food items that have been produced in a manner that minimises environmental harm (Pinard *et al*., 2014). The majority of the studies (74.1%) reported the use of locally sourced ingredients as the most applied sustainable practice in food service operations. From a waste management standpoint, locally sourced ingredients are likely to be fresher and remain fresh for longer, as a result of the reduction in time associated with transportation (Frash *et al*., 2015; Pearson *et al*., 2011). This can possibly have an influence on the time it takes for the food product to spoil and consequent food wastage. Two thirds (66.7%) of the studies reported the use of organic food as a sustainable practice adopted by food service operations. According to Benbrook *et al*. (2008), Niggli (2014), Truong *et al*. (2012) and Shepherd *et al*. (2005), organic food products are premium quality and have a higher nutritional value than conventional alternatives, which leads to a continual increase in demand from consumers. This increased demand may seemingly lead to the reduction in the generation of food waste. On the other hand, Hughner *et al*. (2007) argued that blemishes or imperfections of organic produce might deter consumers from purchasing these, which may lead to the generation of food waste at the producer or retail level. From the perspective of a food service operation, it may be assumed that if the procurement department rejects organic produce on the basis of appearance defects, it can lead to food waste for the agricultural producer or supplier but not the food service operation.

Nearly a third (33.3%) of the reviewed articles on sustainability in food service operations, reported the use of sustainably sourced food items, especially fish and seafood. However, this indicator has not been linked to the generation or prevention of food waste. The utilisation of more plant-based dishes and less animal-based dishes on the menu was reported at 14.8% of the reviewed articles. The linkage of this component to generating food waste in food service operations, remains unknown. Moreover, the use of food in season was mentioned in 11.1% of the studies reviewed. According to Feagan *et al*. (2004), seasonal foods have better quality, and are fresher and tastier than those produced out of season. This may have implications for food waste generation. Fewer articles (7.4%) mentioned the use of animal-welfare approved products. According to the literature, there is an increase in consumer concerns about animal-welfare, which may impact food choices (Horgan & Gavinelli, 2006; Reisch *et al*., 2013). Studies further showed that consumers associate animal-welfare with improved quality, safety and taste (Akaichi & Revoredo-Giha, 2016; Harper & Henson, 2001). Consumer food choices and perceptions about animal-welfare-approved products may have far reaching implications on the consumption of animal-based products, such as meat, eggs and dairy products, and ultimately on the generation of food waste at the food service operation level (Blokhuis, Jones, Geers, Miele & Veissier, 2003). Another sustainable practice, the reduction of processed foods, appeared in 7.4% of the reviewed articles. Despite the extent to which processing foods is unsustainable, it preserves the quality and functionality of food (Lazarides, 2011). Dávila-Aviña *et al*. (2015) contend that processed foods lead to the production of safer foods, enhance their sensory attributes and are more convenient to cook. It is further noted that processed foods are packaged using innovative technologies, such as modified atmosphere packaging or a reduced oxygen-controlled atmosphere, which protects food from microorganisms and other foreign objects, hence extends their shelf life (Dávila-Aviña *et al*., 2015; Sellhewa & Martindale, 2010). These aspects have possible implications on the extent of the food waste generated at the food service operation level.

6.3.3.2 Social sustainability and food waste in food service operations

Social sustainability deals with the practices that ensure social justice and equity, and access to key services, including food security. This dimension was the least reported in the food service literature (n = 4). Social sustainability practices cannot be directly linked to the prevention of food waste, but rather they fall within the components lower in the food waste hierarchy, which are less preferred compared to preventing food waste. For this reason, social sustainability practices cannot be integrated in the framework intended to prevent food waste in food service operations.

6.4 SUMMARY OF FINDINGS FROM PHASE 1

At the end of this phase, a total of eight dimensions of total quality management practices, and 46 indicators of TQM practices were identified in the literature. Further to that, two dimensions of sustainability (social and environmental sustainability) were identified. The environmental sustainability dimension was further categorised into two subfacets; food-focused and environment-focused practices. A total number of 17 major sustainability practices implemented in the food service sector, were identified. The preliminary tool developed at this stage is indicated in Addendum Q.

The next section focuses on the findings from the developmental phase, which aimed at refining the preliminary tool, which was developed in the first phase (predevelopment phase). These findings were informed by a qualitative case study approach, which emphasised the dimensions and indicators of total quality management and sustainability practices that addressed food waste in the specific context of the University food service operations.

PHASE 2: FINDINGS OF THE DEVELOPMENT PHASE

As highlighted in previous sections, there is limited literature on whether or not total quality management practices and sustainability practices can address food waste in food service operations. Given this theoretical gap, the study applied a qualitative methodological approach in the case of the University food service operation to investigate this area. This section therefore, presents the findings obtained from document analysis (D), face-to-face interviews with managers (I), focus group discussions (FG) with front-of-house and back-of-house staff, and participant observations (O). The indicators of TQM; quality practices of top management, customer focus, employee management and involvement, process quality management, employee knowledge and education, supplier quality management, information and analysis, and process and product quality management generated from the analysis of these findings, were applied to develop the tool to address food waste in the University food service operations. The key findings that emerged from the data analysis are presented in Table 6.4 below. These are an integration of the data from different sources applied in this study.

TABLE 6.4: MAJOR FINDINGS FROM DIFFERENT SOURCES AS APPLIED IN THE STUDY

Components	**Dimensions**	**Main findings**	**Methodology applied**			
			D	**O**	**I**	**FG**
TQM Practices	Quality practices of top management	- Management actively participates in quality management efforts	✓	✓		
		- Management holds regular meetings to discuss quality-related issues		✓	✓	✓
		- Management supports quality-improvement efforts by providing the necessary resources	✓	✓	✓	
		- Quality data is taken into consideration in decision-making	✓		✓	
		- The quality policy is communicated throughout the company		✓	✓	
		- Top management gives employees the authority to manage quality problems		✓	✓	
	Customer focus	- There is a documented process of collecting customer feedback.	✓	✓	✓	✓
		- Customers are encouraged to submit complaints and proposals for quality improvement.				✓
		- Customer complaints and proposals for quality improvement are selected.		✓	✓	
		- The organisation's managers and employees are in close contact with the customers.		✓	✓	✓
		- Customers' needs, requirements and desires are recorded and analysed.		✓	✓	
	Employee management and involvement	- Employees who improve quality are rewarded.		✓	✓	
		- Employees participate in quality improvement activities.		✓	✓	
		- Employees take initiatives.		✓	✓	✓
		- Employees recognise superior quality performance.		✓	✓	✓
		- Employees are motivated to improve their performance.		✓	✓	

continues …

Components	Dimensions	Main findings	Methodology applied			
			D	O	I	FG
	Process quality management	- Process non-conformities are detected through internal audits.		✓	✓	✓
		- Critical processes are determined and evaluated.		✓	✓	
		- Determination of areas, processes and points for improvement.		✓	✓	
		- Specific organisational structures have been formulated to support quality improvement.		✓	✓	
		- All employees are provided with instructions.	✓	✓	✓	
	Employee knowledge and education	- Employees are trained in subjects with regard to their specialty and daily work.	✓	✓	✓	
		- Employees have knowledge and know-how.			✓	✓
		- Employees are educated in quality management techniques.	✓	✓	✓	
	Supplier quality management	- Adherence of the suppliers to food quality specifications.	✓	✓	✓	✓
		- Suppliers comply with requested food expiry dates.	✓		✓	✓
		- Suppliers provide food quantities ordered.			✓	✓
		- Suppliers comply with the transportation standards for perishable and non-perishable foods.	✓	✓	✓	✓
		- Timely delivery of the food products by the suppliers.		✓	✓	✓
		- Monitoring and assessing quality performance of the suppliers.	✓		✓	
		- Open communication between the food service unit and the suppliers.			✓	
	Information and analysis	- A variety of data collection methods are used to ensure reliability of quality performance data.	✓		✓	
		- There is a systematic analysis of food quality data.	✓		✓	

continues …

Components	Dimensions	Main findings	Methodology applied			
			D	O	I	FG
	Process and product quality design	***Purchasing***				
		- The expected amount of time is forecast before a food item should be purchased.	✓	✓	✓	
		- Food specifications are developed.	✓		✓	
		- Units of measure are specified in the purchasing orders.	✓	✓		
		- Particular expiry dates are requested when purchasing food items.	✓		✓	
		- Only approved suppliers of food are selected.	✓		✓	
		- Select and establish a variety of suppliers to ensure supply options.	✓	✓	✓	
		Receiving				
		- There are scheduled hours for receiving.	✓	✓	✓	
		- Deliveries are inspected for quantity, against the purchase order and invoice.	✓	✓	✓	✓
		- Deliveries are inspected against the quality specifications.	✓	✓	✓	✓
		- Deliveries are checked to ensure undamaged packaging.	✓	✓	✓	✓
		- Expiry dates of deliveries are checked.	✓	✓	✓	✓
		- Temperature of perishable food is checked upon delivery.	✓	✓	✓	✓
		- Food items that do not meet quality specifications are rejected.	✓	✓	✓	✓
		- All newly received food items are date marked.	✓	✓	✓	✓
		- Received food items are promptly transferred to appropriate storage areas.		✓		

continues …

Components	Dimensions	Main findings	Methodology applied			
			D	O	I	FG
		Storage and inventory control			✓	
		- Storage areas have adequate dimensions for storing all food-related items.		✓		
		- Storage areas meet the specifications for walls, ceilings, floors, windows, baseboards, floor drains, lighting and ventilation.	✓	✓		
		- Storage areas are regularly cleaned.	✓	✓		✓
		- Storage areas have insect and rodent control.	✓	✓	✓	✓
		- Temperature of refrigerators is regularly checked.	✓	✓		✓
		- Relative humidity of refrigerators is regularly checked.			✓	
		- Chemicals and cleaning agents are stored separately from food items.		✓	✓	
		- The organisation of food items in storage areas prevents cross contamination.		✓	✓	
		- The FIFO (First-In, First-Out) rotation system is applied at all times.		✓	✓	
		- Expiry dates of food items are regularly checked.	✓	✓	✓	✓
		- Raw food is stored separately from cooked or ready-to-eat food.		✓	✓	
		- Food is always kept covered.		✓	✓	
		- A continuous track record is kept of food items held in storage.	✓	✓	✓	
		Issuing				
		- A requisition form is used to issue food from storage to production.	✓	✓		
		- Only the quantity of food needed, as specified on an authorised production record, is removed from storage.	✓	✓	✓	

continues …

Components	Dimensions	Main findings	Methodology applied			
			D	O	I	FG
		- Requested items are measured, using appropriate measuring equipment before being issued.		✓		✓
		- Food items issued are checked against standardised recipes before production.		✓		
		- Unused food is returned to the appropriate storage area.		✓		✓
		Production				
		- Use of production schedules.	✓		✓	
		- Ingredients are accurately measured with appropriate measuring equipment.		✓		✓
		- Food items requiring thawing are properly thawed.		✓		✓
		- Food is not exposed to the temperature danger zone for more than 4 hours.		✓	✓	✓
		- Cooking temperature is properly controlled during production.	✓	✓		✓
		- Food is cooked according to the appropriate cooking time.	✓	✓		✓
		- Standardised recipes are adhered to during production.	✓	✓	✓	✓
		- Food is cooked to appropriate, stipulated quality standards.	✓	✓	✓	✓
		- Food is cooked to the appropriate internal temperature.	✓	✓		✓
		- Food is evaluated for quality, prior to meal service.		✓	✓	✓
		- An appropriate procedure is followed for chilling and freezing food.	✓	✓		✓

continues …

Components	Dimensions	Main findings	Methodology applied			
			D	O	I	FG
		Distribution				
		- An appropriate procedure is followed for reheating food.	✓	✓		✓
		- Reheating is done in small batches.		✓		
		- Frozen food is reheated to the appropriate service temperature.	✓			
		- Sensory quality is retained during reheating.	✓	✓		✓
		- Specialised equipment, with approved temperature controls, is used.	✓	✓	✓	✓
		- Food holding temperatures are monitored.		✓	✓	✓
		- Proper equipment is used for distribution.	✓			
		- Temperature of food is properly controlled during distribution.	✓	✓		
		- Time at which food is held while being distributed, is controlled.			✓	✓
		Service				
		- Front-of-house staff check the quality of food before service.	✓	✓		✓
		- Portions of food are verified upon receipt from back-of-house.		✓		✓
		- Bain-maries, chafing dishes and heated cabinets are at the correct temperatures.		✓	✓	✓
		- Internal food temperature is measured and recorded.	✓	✓		✓
		- An appropriate food temperature is maintained during service.		✓		✓
		- Food is kept covered until service.		✓		
		- Standardised serving utensils are used for portioning.		✓	✓	✓
		- Portioning is done correctly.	✓	✓		✓

continues …

Components	Dimensions	Main findings	Methodology applied			
			D	**O**	**I**	**FG**
		- Food is neatly plated and presented.			✓	✓
		- Leftovers are properly handled and stored.	✓	✓	✓	✓
		- The amount of time that the food is held at the temperature danger zone is highly controlled.	✓	✓		
Sustainability practices	Environment focused practices	- Less energy consumption methods.		✓	✓	✓
		- Adherence to optimal cooking times.		✓	✓	✓
		- Batch cooking.			✓	✓
		- Reduced food miles.			✓	
		- Limited use of running water.		✓	✓	✓
		- Use of just enough water for food production.		✓		✓
	Food focused practices	- Use locally sourced ingredients.			✓	
		- Use of food in season.			✓	
		- Use of organic foods.			✓	
		- Cook-to-order.		✓	✓	✓
		- Use of leftovers.		✓		✓
		- Limited use of garnishes.			✓	✓

The following sections provide a discussion on how the different quality management and sustainable practices tabulated above, contributed to the prevention of food waste in the University food service system.

6.5 TOTAL QUALITY MANAGEMENT (TQM) PRACTICES PREVENTING FOOD WASTE

This subsection discusses total quality management practices that contributed to the prevention of food waste, as identified at the case University food service unit. The role of TQM practices in the prevention of food waste in the University food service operation is discussed from the systems perspective, with the view of the TQM approach being an important **control** element of the food service system. The food waste hierarchy framework was integrated, taking into consideration the TQM practices that fall within the most preferred food waste management option, which is prevention.

6.5.1 Quality practices of top management

Quality practices of top management were found to be an important factor that had an influence on preventing food waste in the University food service system. The University food service management, from the Deputy Director (Residence Affairs and Accommodation), Food Service Operations Managers (at head office level) to the Food Service Manager of the central kitchen, participated in the quality improvement strategies of the food service unit. For example, management conducted regular on-site inspections or audits at the University food service unit (O, D). The on-site inspections involved; an internal verification of the procedures and practices that were implemented throughout the food service system, conformed to the policy requirements and set standard operating procedures (SOPs). Food samples were also audited for quality (O). The on-site inspections and audits by management contributed to preventing food waste, as corrective measures were implemented where non-conformities occurred. This improved the food quality and subsequently, prevented food waste that may have otherwise occurred due to non-conformities (Kotsanopoulos & Arvanitoyannis, 2017).

The findings of the study further revealed that management held regular staff meetings to discuss quality and food waste-related issues that played a role in preventing food waste (O, I, FG). Staff meetings served as an important forum that allowed communication (**linking processes**) or the transfer of information between management and food service workers as illustrated in the following commentary:

"… we hold meetings that address any concerns if there are any, if there are challenges in a recipe, we address those quickly in the production meeting, so such mistakes, we try and minimise them through communication in meetings".

In addition to staff meetings held at sectional levels, the University food service unit held management meetings every Monday between sectional supervisors and the food service unit manager. During these meetings, each section reported on their progress, any challenges experienced, meal statistics, food waste and the reasons, including a reflection on quality issues. A Monday reporting tool (Figure 6.7) was used. As noted in the reporting tool, food waste and the reasons were tracked, including quality-related issues. These meetings promoted communication and resulted in collaborative efforts to devise corrective measures to control quality and prevent food waste. In agreement with this, Ofei *et al*. (2015) found that the discussion of food waste-related issues, during morning meetings at the studied nursing home kitchens, provided pathways for communicating new initiatives, which contributed to the reduction of food waste.

It is evident that considering the data on food quality-related issues when making decisions (**linking processes**) was an important factor in preventing food waste (I, D). Typical examples, include the consideration of records (**memory**) on the deviation of the quality and the yield of the food items produced. The food service unit manager stated that each time a food product is produced, the quality and yield were recorded and analysed for consistency. Deviations were analysed and strategies to address these were made, based on the identified root causes. As illustrated in Figure 6.7 below, the reporting tool used by the food service unit, allows for the recording and noting of possible reasons for the variance of the portions produced. Management used this data to suggest corrective measures to prevent recurring food waste. In another instance, the data reviewed by management, revealed that a considerable amount of food, especially rice, lost quality due to overproduction, which resulted in selling reheated rice instead of freshly produced (I, D, O). Given the amount of food waste generated from this practice, management made a decision to reduce the number of pans of cooked rice held for service. This resulted in the reduction of food waste. The continuous response of management to the factors that triggered change and caused food waste in the system, exemplifies the concept of **dynamic equilibrium,** as was discussed in Chapter 2, Section 2.2.4.2. The literature does not include deliberations on how decisions are made when considering the data on food quality-related issues, and how these contribute to the prevention of food waste in food service operations.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

2	MONDAY	Booked	Staff	stock clerk issue (frozen)	thawed kg	Port	COMBO	MENU	STAFF	Returned /	BNT	SNT	other / waste	remark	PORTIONS =Total sales & other= statistics	Variance in portions	Reason for variance & action taken
3											Not incl In total port						
5	Omelette with Cheese	4	8			12.00		4	7	1					12	0	
6	Viennas			1		19.00		4	7	1			7		19	0	7 each Sandwiches(uncooked)
7															0	0	
8															0	0	
9	Combo's														0		
10	Chicken Leg			49.48		200.00	120.00		11				69	Supper co	200	0	
11	Clubsteak			27.68		163.00	88.00		23				52	Supper co	163	0	
12	Fish					57.00	57.00							Supper co	57	0	
13															0	0	
14							Combc Pkt										
15	chips, kg					70.00	49.20	15.65	0.4	6					71.25	1.25	
16	chips, pkt/combo						246	47	2						295		
17	Supper/Lunch														0		
18	Marinated Chicken	49		12.8		49.00		45		4	4				49	0	
19															0	0	
20	Clubsteak	34		6.66		34.00		31		3	3				34	0	
21															0	0	
22															0	0	
23	Production																
24	Bolgnaise Mince					700.00		760							760	60	Recipe to be investigated
25	Chakalaka Sous					28.00		29							29	1	Yield More
26	Chicken Marinade					18.00		15.5							16	-3	Recipe to be investigated
27	Vegetabl Tortilla Wrap					100.00		77							77	-23	Recipe to be investigated
28	Kloostersaal																
29	Ovenbake Chicken Legs			62.84		250.00		250							250	0	
30	Drumsticks			98.94		250.00		250							250	0	
31	Rys					350.00		350							350	0	
32	Sheba					30.00		30							30	0	
33	Sandwich																
34	Cheese	171		171		171.00		171							171	0	
35	Ham	25		25		25.00		25							25	0	
36																	

Monday | Tuesday | Wednesday | Thursday | Friday | Sheet1 | Saturday | Sunday

FIGURE 6.7: MONDAY REPORTING TOOL FROM THE UNIVERSITY RESIDENTIAL FOOD SERVICE UNIT

The findings of the study further indicated that despite the financial challenges, the University food service management made efforts to provide the necessary human resources, materials, facilities and operational resources (**inputs**) to improve the quality at the food service operation (I, O, D). The management also developed and applied procedures that improved quality performance. Figure 6.8 below provides an example of a fishbone diagram, showing the resources available and the procedures to ensure the provision of quality hot meals at the University food service unit. As illustrated in the fishbone diagram, by providing adequately skilled human resources that have been trained on the standards of operations, this enables the production and the service of quality meals. The management provided the necessary facilities (space and equipment), operational resources, including money, time and utilities that supported the provision of good quality, hot meals. The production of good quality meals resulted in the reduction of food waste, as no food items were discarded, as a result of the failure to meet quality requirements and customers' expectations. From a systems perspective, this scenario illustrated the importance of the provision of inputs in supporting the TQM approach, which led to the production of good quality meals (**outputs**), hence the reduction in food wastage. The current literature in the food service field has not investigated this area.

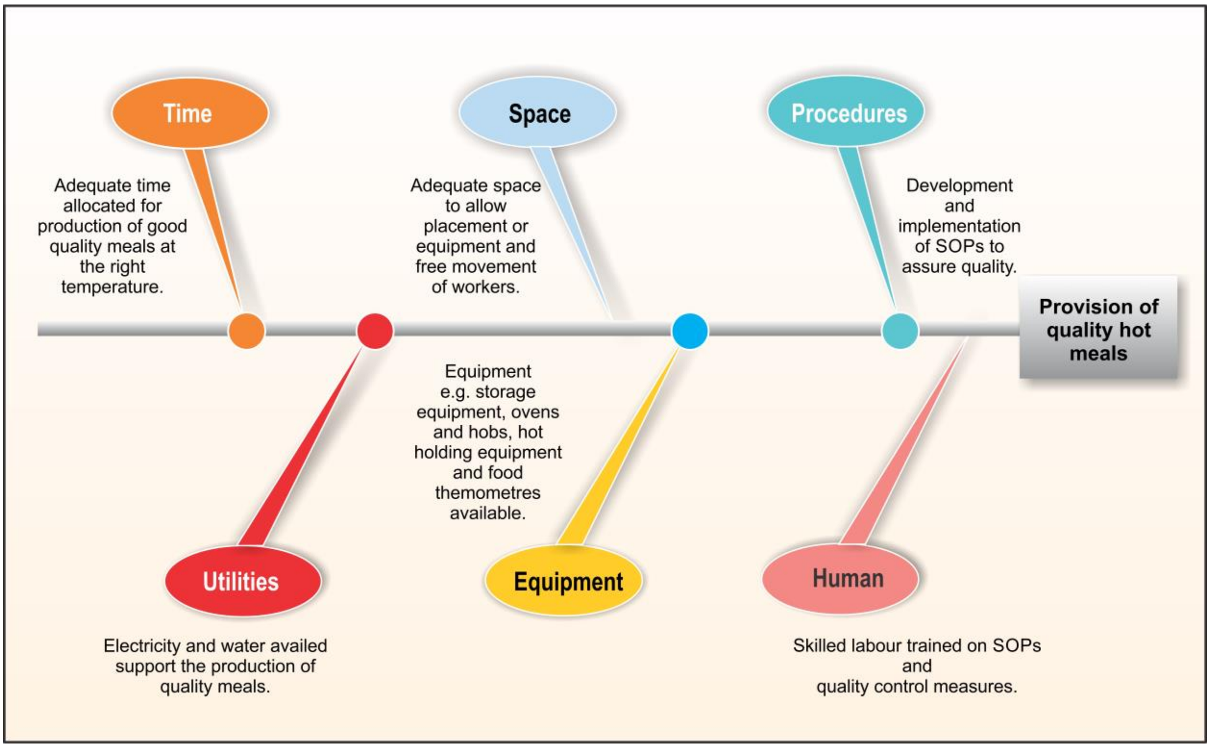


FIGURE 6.8: PROVISION OF RESOURCES AND PROCEDURES BY MANAGEMENT TO SUPPORT QUALITY IMPROVEMENT EFFORTS

The University food service unit introduced several food-related policies and standard operating procedures (SOPs) to reduce food waste. The food quality policy largely helped prevent food waste by improving the quality of the meals that increased acceptability (Ferreira *et al*., 2014). Additionally, the University food service unit adhered to the food safety policy. This was a written document that detailed acceptable food safety practices, identified risks at all stages of the food service system and guided food service workers on the control measures and corrective actions to be taken to ensure the safe production of food and good service of meals. This prevented food waste that would have otherwise occurred if food was unsafe for consumption. The food quality and safety policies were communicated to food service workers at on-the-job training or workshops, meetings, the use of notice boards, day-to-day verbal communication and instructions when workers carried out their assigned duties (O, I). According to the food service manager, this improved the understanding, adherence and commitment to the implementation of food policies, hence production of quality meals, which reduced the generation of food waste. This is consistent with the findings of Goonan *et al*. (2014). Notwithstanding this, there were situations where food quality and safety policies contributed to food waste. This was discussed in detail in Chapter 3.

The study further revealed that management gave employees the authority to manage food quality problems. For example, in the food production department, food service workers were given the authority to adjust recipes and document the adjustments, if they perceived the quality of the food products to be poor (O, I). In this way poor quality was rectified before the point-of-service, hence the prevention of food waste that could have otherwise occurred if the food was rejected by the customers. In agreement with this, Goonan *et al*. (2014) indicated that allowing food service workers to take initiatives increased their responsibility to reduce food waste.

The qualitative findings supported six indicators within the dimension of quality practices of top management and demonstrated that these contributed to the overall quality of food and prevented food waste (Figure 6.9).

6.5.2 Customer focus

From the systems perspective, customer focus is an important part of the **feedback** element. The findings of the study revealed that organisational efforts to establish and improve customer relations contributed to the reduction of food waste (I, O, D, FG). The University food

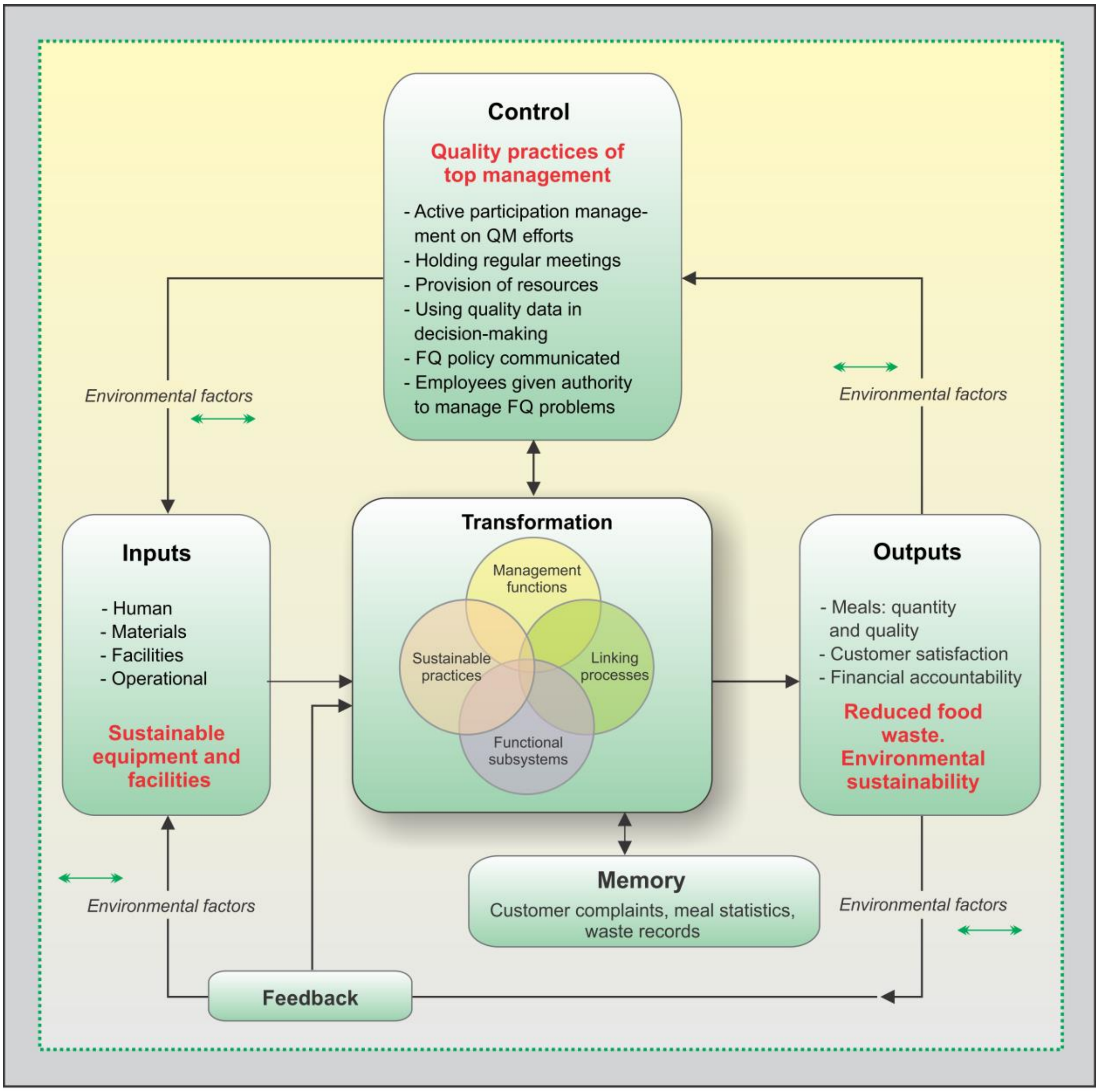


FIGURE 6.9: QUALITY PRACTICES OF TOP MANAGEMENT IN THE FOOD SERVICE SYSTEM

service unit had feedback mechanisms used for communication (**which is part of the linking processes**) between the food providers and students. Specifically, electronic mails, contact forms on the University website (food@up.ac.za), and feedback, or a complaint book were used to collect customer complaints, comments and suggestions (O, FG, I). Students also raised concerns, comments and suggestions directly to the food service workers or food service manager through verbal communication (O, FG). This indicates that the food service organisation's manager and food service workers were in close contact with the customers.

The commentary below illustrates that customers were encouraged to submit their complaints through the different customer feedback mechanisms available (FG).

> *"Yesterday we had a student complaining that the rice they are served has got too much water so they can't eat it, they often go for potatoes and we told him to report such issues instantly so that we can attend to them".*
>
> *"There are a lot of complaints raised by students and we just tell them that they can raise their complaints through emails".*

The University food service unit analysed the given feedback to better understand the customer requirements and to identify areas that needed improvement (O, I). This can possibly reduce the amount of waste generated, as complaints about poor quality meals allowed the food service operation to react to such issues, which may lead to the improvement of quality, hence the acceptance of meals by customers (Heikkilä *et al.*, 2016). The reaction of the staff of the food service unit to the customer complaints demonstrates their ability to respond and adapt to the changing needs of customers; **dynamic equilibrium** (Chapter 2, Section 2.2.4.2). In this way food waste may be reduced before the customers' rejection at the service point. Heikkilä *et al.* (2016) explained that knowing the customers and interacting with them is an essential aspect to improve the quality of the food that leads to customer satisfaction **(output),** hence the reduction in service and plate waste **(output)**.

Figure 6.10 (next page) demonstrates the five indicators of customer focus that contributed to reducing food waste in the University food service system.

As illustrated in Figure 6.10 and as discussed above, customer focus is viewed as a component or practice of total quality management, which when implemented in the food service system, supported the prevention of food waste. In the same way, the focus on the customer enabled the food service unit to obtain information from the external customers (**feedback**) that assisted in making adjustments, correcting errors and improving the system. The records from the customers' suggestions and complaints and the corresponding meal statistics or waste, provided information that was analysed to make the necessary changes.

This possibly impacted on the outputs and contributed to the quality and quantity of the meals, customer satisfaction, reduced both food waste and costs.

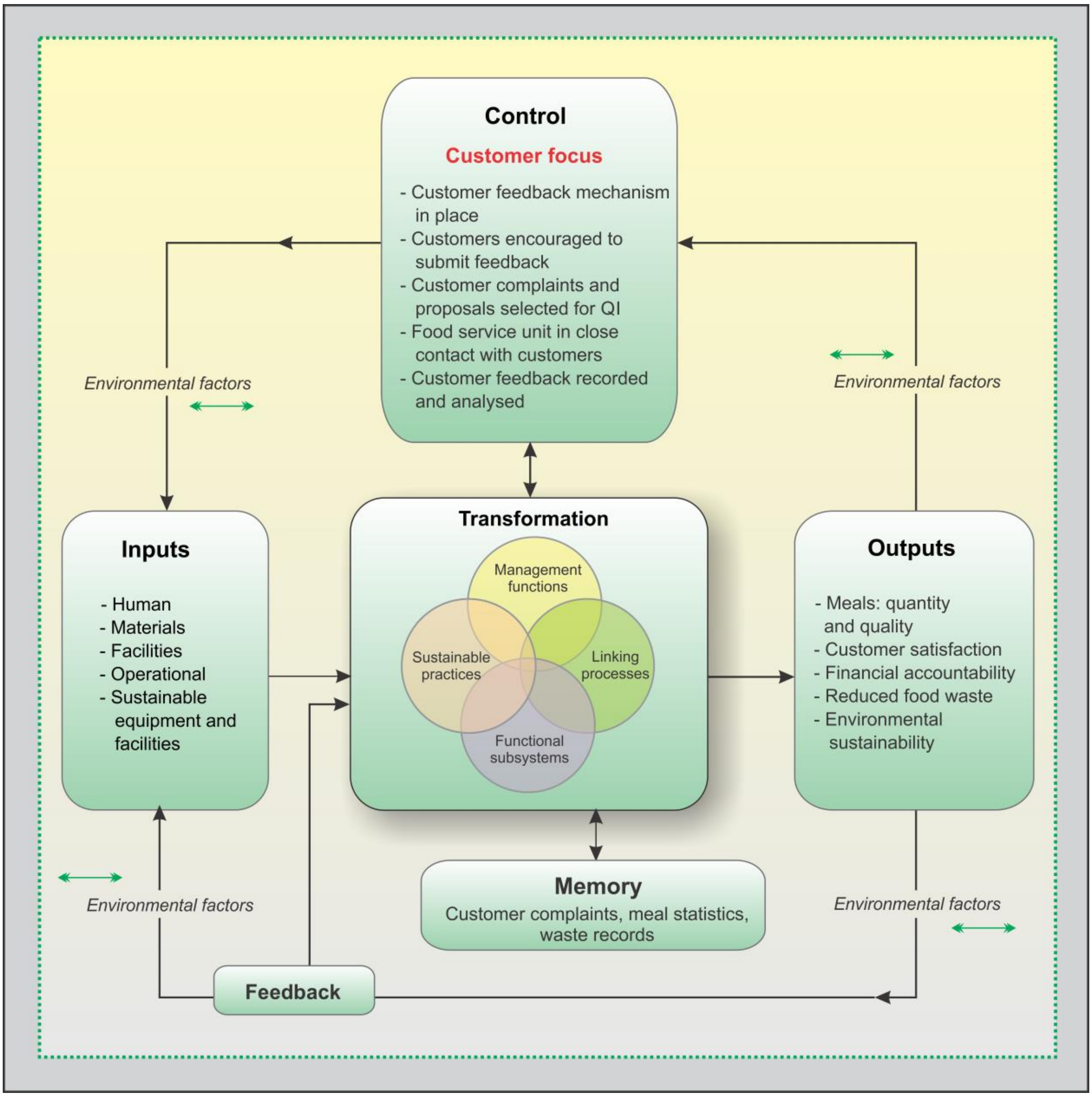


FIGURE 6.10: INDICATORS OF CUSTOMER FOCUS THAT SUPPORTED FOOD WASTE PREVENTION IN THE FOOD SERVICE SYSTEM

6.5.3 Employee management and involvement

The study showed that the management of the employees and their involvement is beneficial in preventing food waste in the University food service unit. Specifically, the participation of food service workers in activities that improved the quality of the food contributed to preventing food waste (O, I). For example, the food production team observed the yield and quality of the food items produced. Any deviations were documented and presented to management to make the necessary adjustments and improve the quality. In addition, food service workers were involved in the execution of the measures to improve the food quality throughout the food production process, such as food temperature checks, meal auditing, including food tasting, as well as portion sizes compared to the standardised portions.

The involvement of staff in quality improvement activities resulted in the motivation to improve performance and commitment towards the provision of quality meals as illustrated in the comment below (I).

> *"The involvement of food service workers in quality improvement activities actually boosts their morale (motivation); they can realise that the work they do is valued and that leads to production of better-quality meals."*

Additionally, one of the supervisors explained that they use team briefings to empower the food service workers (I). The use of team briefings allowed the food service organisation to gain from the employees' experiences, ideas and their feedback, by sharing information and making suggestions. According to Lashley (1995), employees who are involved in quality improvement activities are more committed to participating in solving problems, which leads to improving the quality. This is a preventative strategy that may positively contribute to reducing food waste in food service organisations. The involvement and commitment of every food service worker appears to be important in the prevention of food waste, as it results in the production and service of quality meals throughout the food service processes. Where commitment lacked, the quality of food was affected, hence food waste was generated. This demonstrates the importance of working **interdependently** as a team across the functions of the food service unit to prevent subunit optimisation (Sadikoglu & Zehir, 2010), hence food waste prevention.

During food production, food service workers took initiatives to promptly correct errors that occurred during cooking, so as to produce quality meals (O, I, FG). The commentary below illustrates this:

> *"Food service workers are empowered to take initiatives and make decisions to ensure food quality, for example the other day one of the workers was preparing beef stew and the recipe did not indicate the amount of liquid to be used. The worker noticed this and brought the issue to the management's attention."*

The empowerment of food service workers to take initiatives, prevented food waste before it even occurred in the University food service unit. In another instance, one of the food service workers explained that when the food is transferred from the production unit to service, they evaluate the quality of the meals, especially by tasting, and if the taste is not satisfactory they take the initiative to adjust the seasonings. The implication is that allowing food service workers to take such initiatives to improve quality, led to counteracting food production errors before they occurred, hence the prevention of food waste.

The study further revealed that the recognition of superior performance by supervisory staff, and rewarding the food service workers, motivated them to continue improving the quality of the food, hence the reduction of food waste (I, O). The University food service unit applied "the employee of the month" approach to reward food service workers, who were recognised for superior performance by management. Food service workers, who were recognised for good quality performance, offered support and shared their expertise with other workers to improve the quality of the food. In support of this, Joiner (2007) indicated that when employees feel there is acknowledgement and support from the organisation and from work colleagues, then the implementation of quality strategies is improved. This ultimately eliminated some food production errors and reduced food waste.

In summary, the study supported five indicators of the employee management and involvement dimension and indicated their contribution to preventing food waste (Figure 6.11 – next page). The discussion above, further indicated that the employee management and involvement dimension could be viewed in two ways - as a component of TQM, and as a component of the management function. The findings illustrated the interrelationship between employee management and involvement (TQM / management function), linking processes decision-making and the outputs (employee satisfaction, meal quality, preventing food waste).

6.5.4 Process quality management

The findings of the study showed that an effective process of quality management contributes to preventing food waste in the University food service system. The inspections and internal audits conducted at each stage of the food service operation, detected processes that did not conform (I, O, FG). For example, through internal audits, temperature and time control non-conformities were detected during refrigeration, cooking, hot holding and cold holding; where

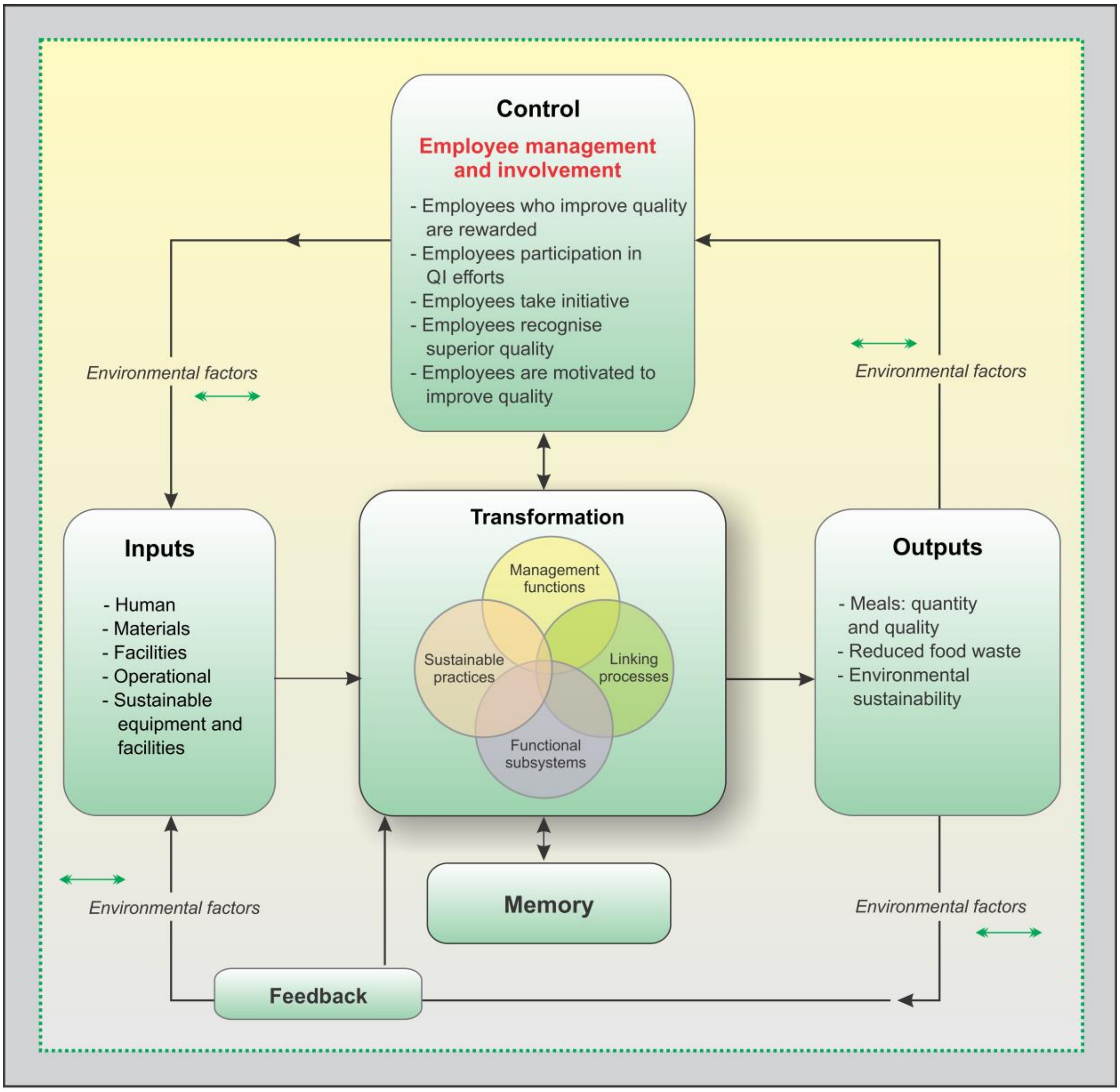


FIGURE 6.11: EMPLOYEE MANAGEMENT AND INVOLVEMENT IN THE FOOD SERVICE SYSTEM

deviations were identified, corrective measures were suggested and implemented. This resulted in reduced waste as quality problems were rectified, hence reduced wastage from incorrect temperature controls (**output**). Internal audits or inspections also assisted in the determination of areas, processes and points for improvement (I, O). This led to the production of quality food that was accepted by the customers, hence reducing food waste.

Additionally, critical processes were determined, standard operating procedures (SOPs) developed, and checklists used to evaluate each process of the food service system (O, I). For instance, at the receiving point, there was a standard receiving procedure; the staff responsible for receiving, used a checklist to conduct checks of the delivery trucks, temperatures and sensory issues. This helped in receiving good quality and safe food, hence reducing the chances of food wastage due to food spoilage. The study further showed that providing food service workers with clear and comprehensive work instructions, with specified desired outcomes, reduced the generation of food waste (O, I, D). Providing work instructions was done through written work procedures, production schedules, notice boards and verbal communication (through meetings and verbal instructions during the execution of work). This created awareness amongst the catering personnel of the expected work procedures and ultimately increased the compliance of the set work procedures, hence reducing food wastage.

Additionally, the formulation of specific structures, within the food service unit to support quality improvement, was found to influence the prevention of food waste (I, O). For example, the University food service unit recognised the challenges with the standardisation of the recipes, which led to food waste; thus a committee was formed to oversee the development and standardisation of recipes. This is illustrated in the comment below:

> *"We have formed the recipe committee now to address the recipe challenges at all levels".*

The recipe committee rectified quality challenges that emanated from poor recipes, which reduced the production of poor quality products, increased product output and thus contributed to the prevention of food waste. In agreement to the findings of the study, Sadikoglu and Zehir (2010) indicated that the management of the employees and their involvement, is an important aspect that significantly contributes to improving quality, as well as foreseeing problems in production, to counteract errors before these occur; this implies that food waste has been prevented.

In summary, five indicators of process quality management were supported by the qualitative findings and were related to preventing food waste (Figure 6.12 – next page). The findings illustrated the interrelatedness of process quality management with the element of management functions, linking processes (communication) and feedback. Interaction among process quality management, employee management and involvement, and information and analysis were implied by interdependency. The implementation of process quality management practices influenced the output of the food service system, including meal quality and food waste prevention.

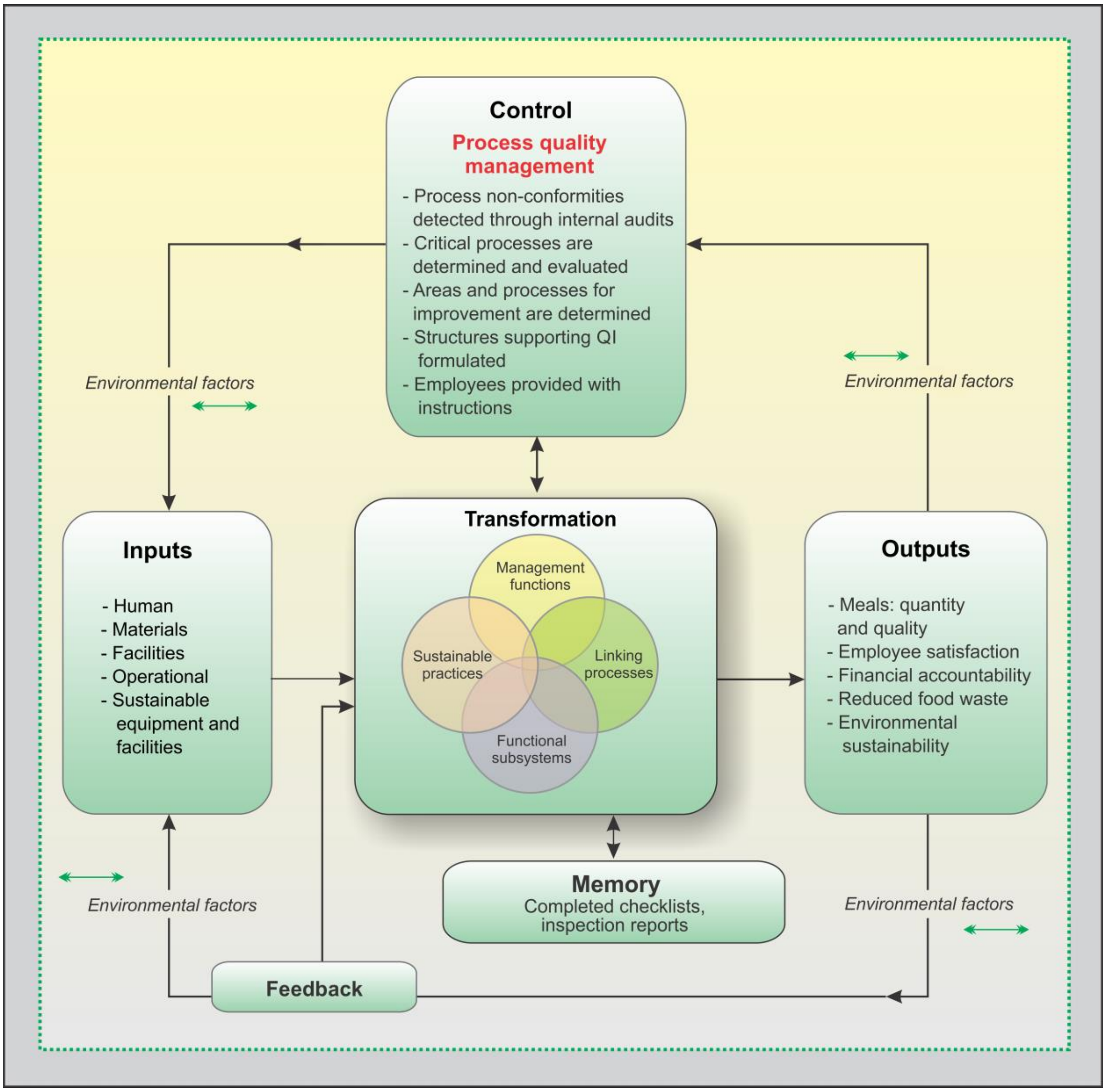


FIGURE 6.12: PROCESS QUALITY MANAGEMENT AND FOOD WASTE IN THE FOOD SERVICE SYSTEM

6.5.5 Employee knowledge and education

The findings indicate that employees, who are empowered to execute their tasks in their current positions, worked more efficiently, produced good quality food and were able to identify errors and rectify them (I, D). The management of the University food service unit offered in-service training for the employees in areas related to their specialised roles in the food service system, food safety and food quality (I, D, O). For example, food service workers at the serving point were regularly trained on portion control and the use of standardised portioning equipment (Figure 6.13). With time, portioning guidelines were adhered to and workers were sensitised to the importance of portion control, hence reducing food waste. In agreement with this, Mosadeghrad (2014) illustrated that employee training enhances the knowledge and skills of the workforce, minimises employees' errors and the need for reproducing faulty products, hence waste reduction.

FIGURE 6.13: IMPROVED USE OF STANDARDISED PORTIONING EQUIPMENT AFTER IN-SERVICE TRAINING

Additionally, employees were trained on food quality management systems, such as the Plan, Do, Check, Act system, and on quality control techniques applied at different phases of the food service system, such as time and temperature control, portion control, sensory analysis, temperature checks and others (D, I, O). The food service manager indicated that continuous training enhanced the workers' knowledge and practice of quality management, and minimised the employees' errors during food production, thus reducing food waste (Mosadeghrad, 2014). Kaynak (2003), Sadikoglu and Zehir (2010) and Talib *et al*. (2013) agreed that continuous training, that includes quality control and techniques, provides sustainability of quality management in an organisation, and transforms workers into creative problem-solvers, who are able to take initiative and solve quality related problems. In this way, quality problems are tackled before errors occur, hence preventing food waste.

The study further found that the employees' knowledge and technical proficiency, which they gained through their work experience at the University food service unit, contributed to the production of good quality meals and the reduction of food waste (FG, I). The following commentary demonstrates this:

> *"The fact that our staff is experienced helps in reduction of food waste because we rarely have cooking errors such as burning food and failing recipes".*

This indicates that the experience of food service workers has a positive influence on reducing food waste. Goonan *et al.* (2014) agreed that previous work experience of kitchen staff was often related to good practices to do with food waste.

In summary, the findings of the study supported three indicators of employee knowledge and education that contributed to preventing food waste. Figure 6.14 (next page) illustrates the employee management and education management dimension in the food service system. Employee management and education impacts on the human resources' level of skill (**input**), their level of competency in performing activities in the functional subsystem of the food service operation, and the quality and quantity of meals.

6.5.6 Supplier quality management

Supplier quality management was shown to be an important factor in preventing food waste. The adherence of the suppliers to food specifications developed by the food service operation, (sample shown in Table 6.5) was identified as having an influence on the prevention of food waste at the University residential food service unit (FG, I, D, O). Strict adherence to specifications enabled the University food service unit to purchase good quality products, which was critical in producing quality menu items, hence preventing food waste.

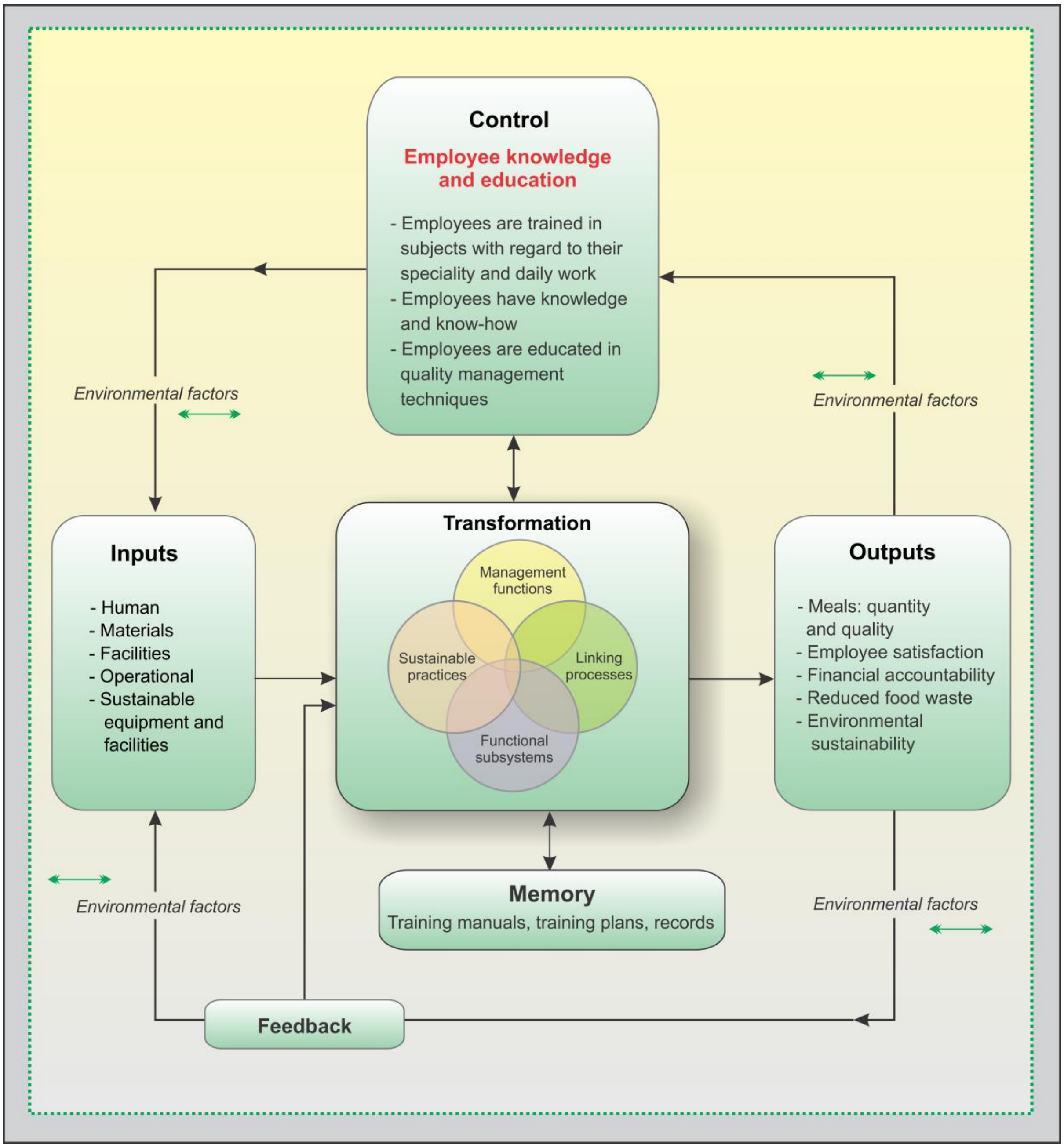


FIGURE 6.14: EMPLOYEE KNOWLEDGE AND EDUCATION AND FOOD WASTE IN THE FOOD SERVICE SYSTEM

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

TABLE 6.5: SAMPLE OF FRESH FRUITS SPECIFICATIONS FOR THE UNIVERSITY RESIDENTIAL FOOD SERVICE UNITS

TYPE OF FRUIT	COLOUR	VISUAL APPEARANCE	SENSORY	SHAPE	MATURITY	PACKAGING AND LABELLING	SHELF LIFE
Red Apple	Dark red block over a striped red blush.	Skin fairly smooth and dry, stem intact. Stems may be missing provided that the break is clean and there is no torn flesh or skin. No foreign matter.	Fine grained, tender juicy flesh; no objectionable odours or tastes.	Round to round-conical, flattened at base/apex. No irregular curvatures or distorted shapes.	Harvested ripe.	Labelling to identify grower's name/brand, size and minimum net weight. Produce to identify 'Packed On' date.	Produce must provide not less than 14 days clear shelf life from date received.
Apple Granny Smith	Ground colour bright green with white flesh.	Stem intact, stem may be missing provided that the breaks are clean and there is no torn flesh or skin.	Skin smooth, crunchy, and not hard with a sweet tangy taste, no objectionable odors or taste.	Elongated tapers to the apex slightly ribbed and crowned at apex no irregular curvatures or distorted shapes.	Harvested ripe.	Labelling to identify grower's name/brand, size and minimum net weight. Produce to identify 'Packed On' date.	Produce must provide not less than 14 days clear shelf life from date received.
Apple Golden Delicious	Light green to very pale yellow skin, creamy flesh tinged with green.	Stem intact, stem may be missing provided that the break is clean and there is no torn flesh or skin.	Skin dry, Highly aromatic with a sweet crisp taste, no objectionable odour or taste.	Elongated tapers to the apex slightly ribbed and crowned at apex, no irregular curvatures or distorted shapes.	Harvested ripe.	Labelling to identify grower's name/brand, size and minimum net weight. Produce to identify 'Packed On' date.	Produce must provide not less than 14 days clear shelf life from date received.

The participants of the study indicated that strict adherence to food specifications ensured the procurement of good quality products, as illustrated in the commentary below:

> *"We have specifications of the products that is on the meats, veggies and fruits and stuff, so that helps if you order like roasted veggies you can see whether they adhere to specifications".*

Another participant commented:

> *"We have specifications in place. The products that we buy I think are of very high quality; we do not go for cheap products and bad quality".*

Another one said:

> *"We start where we get the products to ensure that it's good quality so there are specifications agreed upon between us and the suppliers, so upon receipt of that product it is ensured that it is at the correct specifications".*

Ensuring compliance of the suppliers to the food specifications, developed by the University residential food service unit, resulted in the procurement of good quality food products, hence minimising food wastage that could have resulted from spoiled or poor quality food items. Additionally, the University residential food service unit made a specific request for the supply of food products with a sufficiently long shelf life as indicated in Table 6.5 above (D, I, FG). Compliance with the requested food expiry dates by the suppliers, assisted in preventing food waste that could result from food spoilage (Betz *et al.*, 2015). It was further found that the provision of the right quantity of products that were ordered, reduced food wastage (FG, I). This finding may be explained by the fact that the provision of the right quantity of food products as ordered, may lessen the chances of overstocking.

Another factor; suppliers' compliance with the transportation standards for perishable and non-perishable foods, including the cleanliness, the correct temperature and proper storage of food in the delivery truck, was found to be important to prevent food waste (O, FG, I, D). In line with this, it was noted that:

> *"Another thing is to check the temperature on the trucks, so if the temperature on the trucks is incorrect, we don't take the stuff because then it means they won't be of good quality. The other thing we do is inspect the trucks inside as well, there must be a curtain, one of the trucks didn't have a curtain so we*

> *complained about that and they put the curtain up so the temperature is so much better and also inside, the texture used to be in a terrible state because every time they used to go around the boxes would collide".*

As indicated in this narration, when suppliers failed to comply with the required transportation standards, the delivery was rejected as the quality of the food was possibly compromised. Compliance to the transportation standards was important, as it ensured the delivery of good quality products that did not spoil easily, hence reducing food wastage. The timely delivery of food products by suppliers was also important to prevent food waste (O, FG, I). The University food service unit had a food delivery schedule for different suppliers. This enabled the food service unit to plan for deliveries and obtain food products at such periods that they would not lead to higher than required inventory levels. In this way, the proper receiving of food, its storage, and avoiding overstocking were ensured, hence preventing food waste.

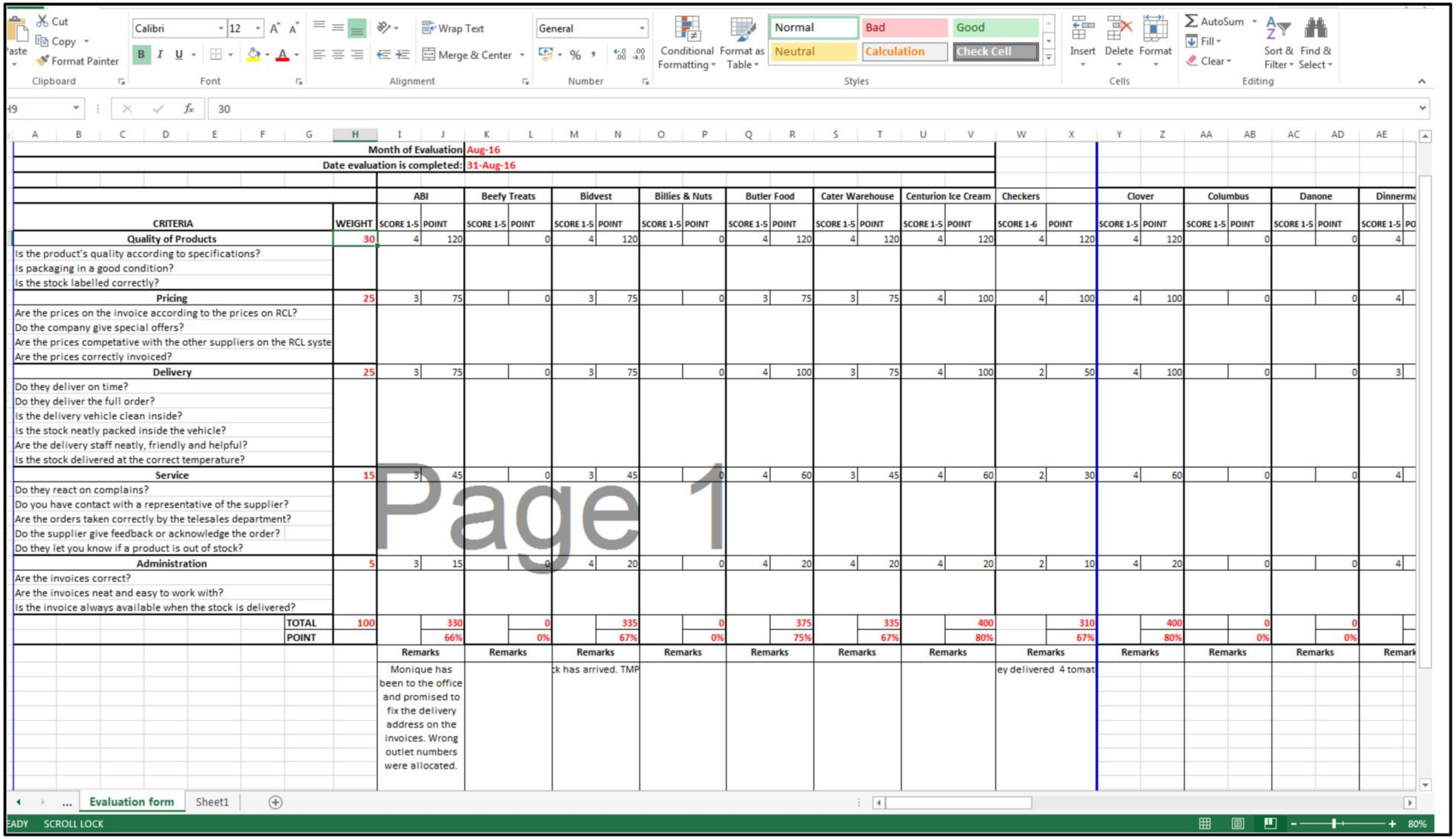
Food waste was further prevented through monitoring and assessing the quality performance of suppliers (I, D), which is an integral part of the University food service system. The participants of the study suggested that this contributed to preventing food waste, as it ensured that the suppliers were meeting performance expectations and that quality products were delivered (I). Participants commented that:

> *"I think the management of quality starts with a supplier and there the Purchasing Consortium Southern Africa (PURCO) plays a big role in selecting reputable suppliers. We also do visit suppliers, new suppliers are visited to check their facilities, check their products and even contact some of the previous buyers that have used the supplier".*

Additionally, the procurement supervisor at the food service unit level, performed monthly evaluations of the suppliers, as indicated in the comment below:

> *"At the end of the month I write a suppliers' evaluation of all the suppliers about how they perform and that goes to the manager of the Purchasing, Contracts and Stock Control Division of the University Food Services and she has meetings with suppliers on regular basis, she gives them feedback and they have to rectify the issues noted on the suppliers' evaluation".*

The tool used to evaluate the quality performance of suppliers is shown in Figure 6.15. It captures elements, such as quality of products, pricing, delivery conditions, service and administration issues, which have an influence on food waste.



Month of Evaluation: Aug-16

Date evaluation is completed: 31-Aug-16

CRITERIA	WEIGHT	ABI SCORE 1-5	ABI POINT	Beefy Treats SCORE 1-5	Beefy Treats POINT	Bidvest SCORE 1-5	Bidvest POINT	Billies & Nuts SCORE 1-5	Billies & Nuts POINT	Butler Food SCORE 1-5	Butler Food POINT	Cater Warehouse SCORE 1-5	Cater Warehouse POINT
Quality of Products	30	4	120		0	4	120		0	4	120	4	120
Is the product's quality according to specifications?													
Is packaging in a good condition?													
Is the stock labelled correctly?													
Pricing	25	3	75		0	3	75		0	3	75	3	75
Are the prices on the invoice according to the prices on RCL?													
Do the company give special offers?													
Are the prices competative with the other suppliers on the RCL syste													
Are the prices correctly invoiced?													
Delivery	25	3	75		0	3	75		0	4	100	3	75
Do they deliver on time?													
Do they deliver the full order?													
Is the delivery vehicle clean inside?													
Is the stock neatly packed inside the vehicle?													
Are the delivery staff neatly, friendly and helpful?													
Is the stock delivered at the correct temperature?													
Service	15	3	45		0	3	45		0	4	60	3	45
Do they react on complains?													
Do you have contact with a representative of the supplier?													
Are the orders taken correctly by the telesales department?													
Do the supplier give feedback or acknowledge the order?													
Do they let you know if a product is out of stock?													
Administration	5	3	15		0	4	20		0	4	20	4	20
Are the invoices correct?													
Are the invoices neat and easy to work with?													
Is the invoice always available when the stock is delivered?													
TOTAL	100		330		0		335		0		375		335
POINT			66%		0%		67%		0%		75%		67%
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Monique has been to the office and promised to fix the delivery address on the invoices. Wrong outlet numbers were allocated.				k has arrived. TMP							

CRITERIA	Centurion Ice Cream SCORE 1-5	Centurion Ice Cream POINT	Checkers SCORE 1-6	Checkers POINT	Clover SCORE 1-5	Clover POINT	Columbus SCORE 1-5	Columbus POINT	Danone SCORE 1-5	Danone POINT	Dinnerma SCORE 1-5	PO
Quality of Products	4	120	4	120	4	120		0		0	4	
Pricing	4	100	4	100	4	100		0		0	4	
Delivery	4	100	2	50	4	100		0		0	3	
Service	4	60	2	30	4	60		0		0	4	
Administration	4	20	2	10	4	20		0		0	4	
TOTAL		400		310		400		0		0		
POINT		80%		67%		80%		0%		0%		
	Remarks		Remarks		Remarks		Remarks		Remarks		Remark	
			ey delivered 4 tomat									

FIGURE 6.15: EVALUATION FORM OF QUALITY PERFORMANCE OF SUPPLIERS

Some of the issues raised during the suppliers' evaluation included:

> *Supplier A: "Still out of stock and do not always let us know when stock has arrived. TMP7788, 7787, 7761 (purchase orders) were some of the orders that were out of stock".*

> *Supplier B: "They delivered some orders twice because there was no order number on the invoice. That was rectified. They again delivered cheese loaves instead of grated cheese. The rep rectified that, on the 31st they delivered 4 tomato sauces instead of 36 tomato sauces and 1 Worcester sauce. The invoice was wrong. They also forgot to deliver an order according to them they lost it during a power surge. The order was delivered later".*

> *Supplier C: "Two orders not delivered. When inquiring nobody could help. Kept on referring to staff that could not assist".*

The information obtained from the suppliers' evaluation tool served as **feedback** and was used for decision-making of suppliers for subsequent deliveries (**linking processes**). Additionally, suppliers used feedback on the evaluation for taking corrective measures (**balance**). This led to the improvement in quality performance by suppliers, hence the reduction in food waste (**output**).

Open communication (**linking processes**) between the food service unit and the suppliers was found to be an important element in reducing food waste (I). One of the participants pointed out that:

> *"In the past our meat supplier changed the packaging without letting us know and it didn't work for us because it was big boxes so it took more storage space and it was not as they discussed it. I phoned them and I said this isn't working and she said "oh sorry she forgot to let us know, it wasn't supposed to come to us and they stopped. So, most of the times I can sort it out with the suppliers directly and I mention it to management during the meetings".*

It was indicated that when the quality of food products did not meet the quality standards of the food service unit, communication was made with the suppliers; the food products were substituted or replaced with better quality products. In this way, food waste was prevented. The comparison of the findings with those of other studies, confirms that better communication between the suppliers and food service operations prevents food waste; for example, complaints communicated to suppliers about incorrect deliveries, poor food delivery standards, and poor quality products, resulted in corrective measures being taken (Heikkilä *et al.,* 2016).

The findings of the study supported seven indicators of supplier quality management that had an influence on food waste prevention. Supplier quality management is a dimension of TQM, which is a component of the control element. As discussed above and as shown in Figure 6.16 (next page), there is an interdependency between supplier quality management and other elements of the food service system.

6.5.7 Information and analysis

The systematic recording and analysis of organisational data played a role in the prevention of food waste at the studied University residential food service unit (D, I). Data was collected using a variety of tools (I, D) such as:

- Supplier evaluation tool;
- Purchase orders;
- Product receiving log sheets (used while receiving food products from suppliers);
- Record of items returned to suppliers;
- Stock movement sheets;
- Food daily control sheets (recording the movement of food);
- Work in progress (recording a list of cook-chilled or frozen food items available in the cold storage);
- Temperature control log sheets;
- Recipe production records;
- Daily food production plan;
- Oil monitoring log sheets;
- Daily serving log sheets (used by front-of-house staff to record an evaluation of food prior to service);
- Daily production waste records;
- RCL waste records (food wasted in storage); and,
- Financial records and others.

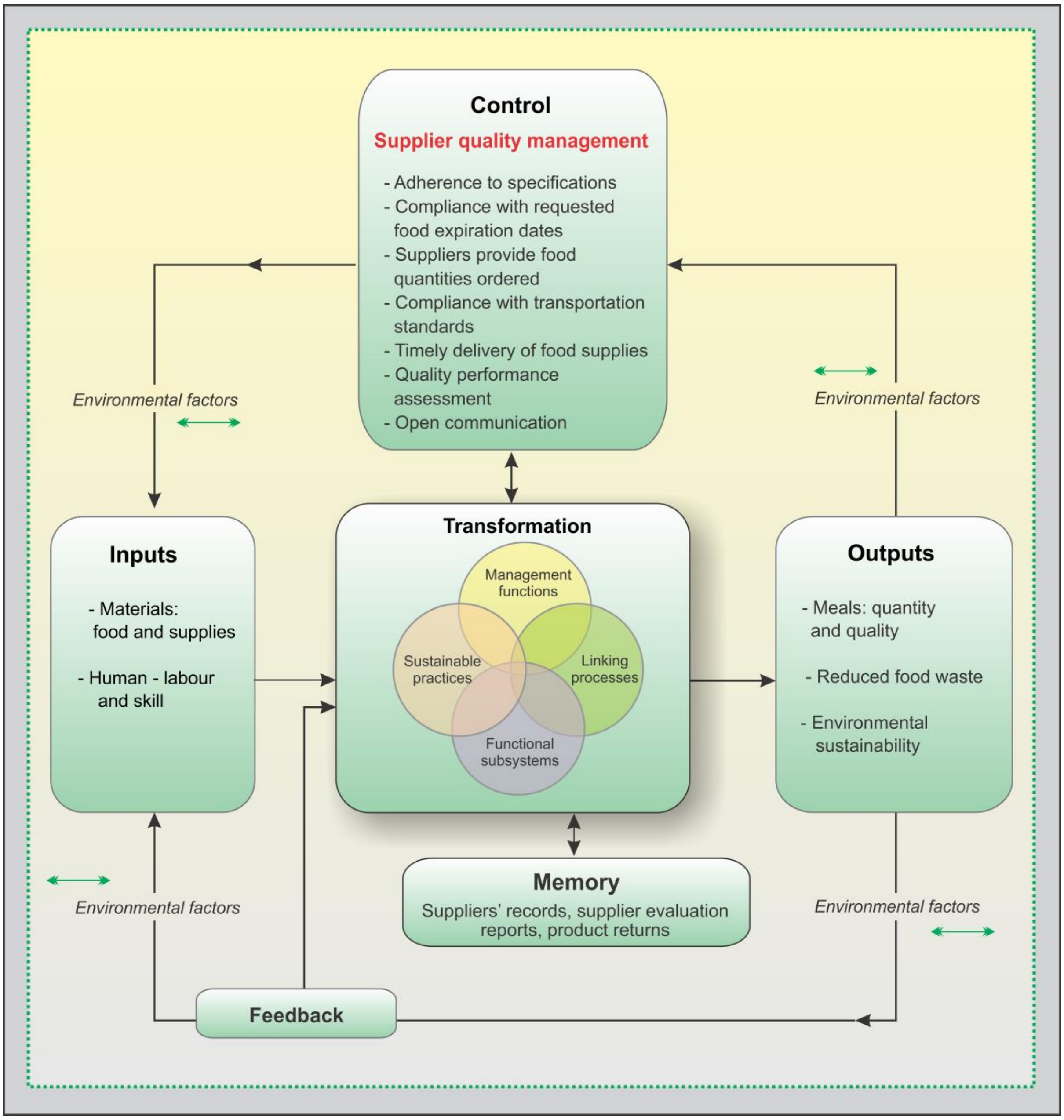


FIGURE 6.16: SUPPLIER QUALITY MANAGEMENT IN THE FOOD SERVICE SYSTEM

Data from these tools were analysed (**feedback**) and used to make organisational decisions (**linking processes**). For example, data obtained from stock movement sheets, was used to inform the production division of food items that are available and nearing expiry, so that the a la carte (combo) menu could be planned, such that these food items are used. Additionally, such information informed management about the popularity of the different food items, so that the least popular items could be omitted from the menu plans. Participants of the study further indicated that the analysed data informed the procurement division about stock levels, which assisted in forecasting and ordering food items to avoid overstocking (I). In this way, food waste generation was reduced. Empirical research on the role of information and the analysis of preventing food waste in the context of food service operations, is limited.

The findings of the study supported two indicators of information and the analysis dimension that had an influence on food waste prevention. As illustrated in Figure 6.17 below, information and analysis are a part of TQM, which is a component of the controls. Information and analysis can also be viewed as **memor**y, as these dealt with the collection and analysis of the information used in the food service system. The analysis of such records provided management with important information, which enabled them to respond to various factors affecting the operation of the University food service system, while maintaining a steady state (**dynamic equilibrium and balance**). The analysis and utilisation of the information obtained, helped the food service operation to achieve the desired outputs and reduce food waste.

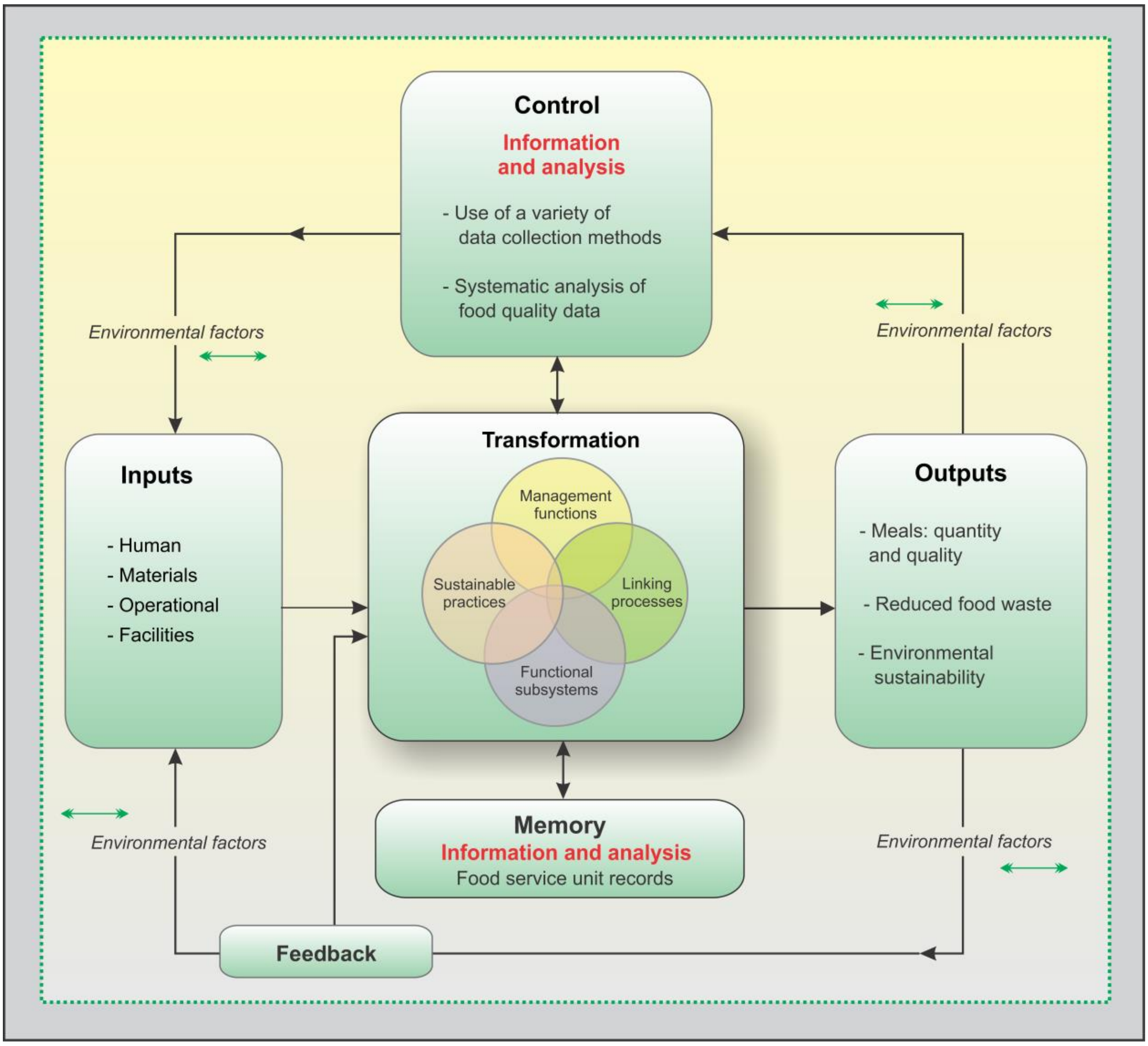


FIGURE 6.17: INFORMATION AND ANALYSIS IN THE FOOD SERVICE SYSTEM

6.5.8 Process and product quality design

Process and product quality design refer to the extent to which an organisation performs activities and processes to produce and deliver good quality products and services (Talib *et al*., 2013). In this study, the activities carried out throughout the functional subsystem (**transformation** part) of the food service system, were investigated to explore their potential contribution to preventing food waste. The next section, therefore, discusses the findings in this regard.

6.5.8.1 Purchasing

The University food service unit applied various measures to mitigate food waste at the point of purchasing. Accurate stock forecasting was identified as an important factor in preventing food waste (O, I, D). The University residential food service unit used an automated stock control system, that kept track of items going into and out of food storage, thus enabling the food service unit to forecast the amount of food to purchase, based on the stock movement and stock levels (stock on order, and stock on hand). The findings are in accordance with the recent studies of Okumus (2020) indicating that the use of technology in forecasting, stock control and purchasing, contributes to preventing food waste. This helped in avoiding overstocking and ordering appropriate amounts of food for a given period, hence preventing food waste (Derqui *et al*., 2016; Halloran *et al*., 2014; Heikkila *et al*., 2016; Irish Environmental Protection Agency, 2014). Additionally, food specifications were developed, to which suppliers had to comply (I, D). Similar to the findings of past research (Charlebois *et al.,* 2015), the adherence to the food specifications ensured that the food service unit obtained good quality products, hence food was not wasted from possible spoilage or poor-quality menu items. Food deliveries from suppliers, who failed to comply with food specifications, were rejected to avoid the absorption of food waste by the University food service unit (I, FG, O, D). However, this prevented food waste at the food service unit level but generated waste for the supplier. This illustrates the necessity to employ a life cycle assessment (LCA) approach and consider the potential environmental impact throughout a product's life (i.e., from cradle-to-grave), hence preventing food waste at all stages of the food product's life cycle. The implication is that the **interdependency** of the different systems in the food supply chain is critical in food waste prevention.

To place an order, the food service unit developed a purchasing order form, indicating the description of the item, weight or size required, quantities required, price and supplier (D, O). This ensured that the right products were ordered and correct quantities delivered. In this way, food waste was prevented as only the deliveries matching the purchase order were received thus avoiding overstocking. When ordering food supplies, the University food service unit made a request for the supply of perishable food with sufficiently long shelf life (D, I). This helped prevent waste that could occur through food spoilage (Betz *et al.,* 2015). The University residential food service unit selected reputable suppliers, who were registered with the Purchasing Consortium Southern Africa (PURCO) to ensure the procurement of quality food products, which enabled the production of good quality menu items and prevented wastage from food spoilage. Additionally, the food service unit selected and established a variety of suppliers to widen the supply options (I, D, O). As mentioned in the comment below, the lowest bidding supplier was given first priority.

> *"What we have on the stock management system is that we say which supplier is the cheapest, so we will put a 1, and a 2, and a 3, and a 4 as our suppliers' options".*

Another criterion; quality, which was established through visits to the suppliers' facilities and supplier evaluations, was an important factor in the selection of suppliers. Ensuring a wide option of suppliers prevented food waste in two ways; 1) when Supplier A failed to meet the University residential food service unit's expectations, Suppliers B, C or D were chosen so as not to compromise on food quality, 2) when supplier D did not have the ordered food products in stock, other suppliers were considered to ensure the availability of menu items of the quantity and quality promised to the customer, hence customer satisfaction (**outputs**).

A total of six indicators were found to contribute to prevent food waste under the purchasing subsystem.

6.5.8.2 Receiving

To minimise food wastage at the receiving point, the University residential food service unit scheduled specific hours to receive deliveries (I, D, O). This prevented food waste in that the availability of the receiving staff at the scheduled hours was always guaranteed, which ensured prompt receiving and movement of stock to the appropriate storage areas, hence minimising food temperature abuse and food spoilage. Additionally, this strategy helped in controlling stock levels, as deliveries were scheduled in such a way that the ordered ingredients could be used within a reasonably short period of time, while still in a fresher state (I). Another important finding was that the inspection of the deliveries prevented food waste, as this practice ensured that the delivered food products were as specified on the purchase order, met food specifications, had not expired, were of good quality and the packaging was not damaged (D, O, I, FG). These findings broadly support the work of other studies in the area (Charlebois *et al.*, 2015; Pirani & Arafat, 2014) that linked the inspection of food deliveries to the prevention of food waste. Contrary to these findings, Garrone *et al*. (2014) argued that the rejection of the food supplied on the basis of damaged packaging in particular, is not justified as the intrinsic quality of the food is not affected and generates unnecessary food waste to the supplier. This discrepancy could be attributed to the difference in the type of food product investigated.

The food products that did not meet the set standards and specifications were immediately rejected and returned to the supplier to avoid food waste on the part of the food service unit (D, O, I, FG). In the same way, the temperature of perishable food items was checked and those that were above the appropriate temperature were rejected to avoid food wastage due to spoilage. This is illustrated in the comment below:

> *"If the suppliers deliver bad quality products, we reject the products. We do the receipt-return voucher stuff, it goes back and then automatically they will send the payment to finance. Another thing is to check the temperature on the delivery trucks, and of perishable food delivered, so if the temperature is incorrect, we don't take the foodstuff".*

Checking the temperature of perishable food upon delivery was therefore, viewed as an important part of reducing food waste in the University food service establishment. In accordance with the present findings, Bilska, Tomaszewska and Kołożyn-Krajewska (2020) demonstrated that checking the quality of the food delivered, as well as the temperature of refrigerated products contributed to the reduction of food waste in food service operations. Kantor, Lipton, Manchester and Oliveira (1997) further explained, that refrigerated and fresh foods transported at improper temperatures or with signs of temperature abuse deteriorate, wilt, or suffer bacterial degradation or microbial growth. Rejecting such products therefore, prevented food waste, as poor-quality products that may easily spoil, were not accepted.

The current study also found that labelling delivered food items upon receiving, played an important role in preventing food waste (D, O, I, FG). The receiving personnel labelled the food clearly, indicating the date of receipt or delivery, the expiry date, the product name and storage instructions. This information helped food service workers to better control the inventory and easily identify the oldest stock, hence minimise food spoilage. These findings reflect those of Creedon *et al*. (2010) and Ghanem (2020), who also found that labelling food during receiving was imperative in preventing food waste. All received products were promptly transferred to the appropriate storage areas, starting with perishables followed by non-perishables (O). In support of this practice, Engström and Carlsson-Kanyama (2004) agreed that the transfer of deliveries must be done in the shortest time possible to prevent food spoilage by maintaining the appropriate temperature.

According to the findings of the study, a total of nine indicators contributed to preventing food waste within the receiving element of the University food service system.

6.5.8.3 Storage and inventory control

The findings of the study generally linked good storage and inventory control practices to food waste prevention. It was found that adequate dry and cold storage spaces (shown in Figure 1.5, Chapter 1) enabled food service workers to store all food items appropriately (O, I) thus preventing food waste. These findings reflect those of Filimonau, Todorova, Mzembe, Sauer and Yankholmes (2020) and De Moraes, De Oliveira Costa, Pereira, Da Silva & Delai (2020), who found that providing adequate storage facilities is important to maintain food quality and prevent food waste. Adequate storage spaces made it easy to arrange food in a manner that allowed easy access, hence minimising food wastage that might have otherwise occurred, due to spillages, breakages and spoilage (Ghanem, 2020). Additionally, the dry storage areas had windows that open, doors, and fans that allowed storage areas to stay cool and dry, and well ventilated (O). In this way the temperature and humidity remain constant (Rostami, Naddafi, Arfaeinia, Nazmara, Fazlzadeh & Saranjam, 2020). The buildings for dry storage were well maintained with adequate lighting, doors and windows closing properly, ceilings, floors, baseboards and floor drains in good condition (O, D). Ensuring optimal storage conditions possibly helped in preventing food spoilages (Beretta *et al*., 2013; Betz *et al*., 2015; Marthinsen *et al*., 2012).

Another finding was that keeping clean storage areas contributed to preventing food waste. The University food service unit adhered to a cleaning and sanitising programme to maintain regular cleaning of the food service facility, including the storage areas (D, O, FG). This is illustrated in the following comments from the participants.

> *"At the storage point we have a cleaning programme and schedule, and this helps prevent food contamination and spoilage".*

Another participant also said:

> *"There is a specific cleaning programme for the staff that has to be adhered to".*

As evidence of regular cleaning, a checklist was completed after each scheduled cleaning routine (D). As indicated in the comment above, regular cleaning of the storage spaces prevented food contamination and spoilage, thus reducing food wastage. A possible explanation for this might be that clean and sanitised surfaces lessened both the risk of contamination and the introduction of pathogenic microbes in food. This preserved the quality and safety of the food thus reducing the chances of food wastage due to spoilage and contamination (Her, Seo, Choi, Pool & Ilic, 2019). Another possible explanation is that keeping the food storage areas clean and well-maintained, prevented pest infestations thus minimising the risk of food waste.

The University food service establishment employed several strategies, which ensured that storage areas were free from insects, rodents and other pests. These included the regular maintenance of the premises to prevent the entry of pests, and if necessary, engaged pest control specialists to conduct routine inspections and apply pest control methods when needed (D, O, FG, I).

The comment made by one of the research participants illustrated the pest control measures put in place by the University food service unit:

> *"The policy is that before we close, we get the pest control specialists to come and apply pesticides for common pests. Every month the pest control specialists inspect the food service premises and the reports are filed in the pest control files. The food service workers also promptly report pests and insects as soon as they are identified".*

In this way, food waste from contamination and damage by pests was prevented. In support of the findings, a study conducted in the retail context, demonstrated that employing mitigation strategies to ensure storage facilities free of pests, is important in preventing food waste (De Moraes *et al*., 2020).

Chemicals and cleaning agents were stored in an appropriate manner, separately from food supplies (O, I). Storing foods under the correct conditions, and separately from chemicals and cleaning agents, possibly preserved their quality and prevented food contamination thus eliminating the probability of food waste due to these factors (Faour-Klingbeil, Kuri & Todd, 2020). The study further demonstrated that good temperature control in the cold storage rooms and freezers was an important factor in preventing food waste (O, D, FG). The temperatures were regularly monitored and recorded on temperature control check sheets. Temperatures of the cold storage rooms were kept between 1 - 4ºC, and freezer storage rooms kept at below -18ºC (D), hence preventing food waste. The finding may be explained by the fact that good temperature control preserves the quality and safety of food, as it inhibits the growth of harmful pathogenic bacteria and prevents spoilage (Taha, Osaili, Saddal, Al-Nabulsi, Ayyash & Obaid, 2020). In addition to this, monitoring and controlling the relative humidity of the storage areas contributed to preventing food waste (I). According to Lipińska, Tomaszewska and Kołożyn-Krajewska (2019), the factors determining the growth rate of micro-organisms, responsible for the spoilage of food products, include temperature and ambient humidity. This explains the influence of relative humidity on preventing food waste.

The study further demonstrated that the organisation and separation of food items in the storage areas was an important factor in food waste prevention (O, I). For example, raw food items were stored covered and separately from cooked or ready-to-eat food items, thus preventing cross contamination. One of the study participants also mentioned that:

> *"We store food products in different storage areas according to food type. Vegetables are kept in a specific cold storage separately from meat products. Cooked food items are also stored isolated from raw food items and this prevents cross-contamination."*

The comparison of the findings with those of other studies, confirms that the separation of different food items prevents food spoilage thus preventing food wastage (Okumus, 2020). In support of this, Ghanem (2020) indicated that storing different food products separately, such as storing tomatoes, separate from lettuce, minimised waste caused by the emission of gases from the tomatoes, which turns lettuce brown.

The implementation of the First-In, First-Out (FIFO) approach at the University food service establishment was important in food waste prevention (I, O). This is illustrated in the commentary below:

> *"At the storage point I think applying FIFO prevents food waste".*
>
> *"FIFO, First-In, First-Out. It's very important that is why we count stock on a weekly basis so that we can check the expiry dates. If the stock is standing for too long, I usually talk to the production supervisor and ask her to utilise the products somewhere in her menu".*

In accordance with the present findings, previous studies have demonstrated that applying the First-In, First-Out (FIFO) approach, ensured that the old stock was used before the newly purchased food products, thus minimising storage waste (Charlebois *et al*., 2015; Creedon *et al*., 2010; Derqui *et al*., 2016; Marthinsen *et al*., 2012; Pirani & Arafat, 2016). Filimonau, Zhang and Wang (2020) explain that adopting the FIFO approach, i.e. prioritising the earlier foodstuffs purchased or those nearing the expiry date in meal preparation, was important in reducing food waste, due to spoilage or expiry during storage. In relation to this, the University residential food service unit regularly tracked expiry dates of food items so as to avoid food waste as a result of expired foodstuffs (I, O, FG, D). As stated above, food items nearing the expiry date, were used in flexible menus (combos) and this contributed to the prevention of food waste at the storage point. This finding broadly supports the work of other studies in this area (Betz *et al*., 2015; Derqui *et al*., 2016; Filimonau, Zhang & Wang, 2020, Ghanem, 2020), of those who illustrated that regularly checking the expiry date of food products and utilising those that were reaching expiry, contributed to preventing food waste in food service operations.

Other approaches adopted by the University food service unit included constant tracking of the food items in storage (D, O, I) and counting on a weekly basis. This was recorded on a stock movement report, which provided an indication of the expiry dates and the quality of all the items in the store, and whether or not the stock levels corresponded with the information found on the automated stock management system. The continuous tracking of the food items provided an accurate reflection of the stock levels and stock movement; this helped with the planning of food production by using the food items available, and stock forecasting, hence avoiding overstocking (Charlebois *et al*., 2015). To reduce food waste occurring, the University food service unit covered food during storage (I, O). However, as discussed in Chapter 5, some food items were stored uncovered and this resulted in the loss of aesthetic qualities, due to drying and wilting, hence food waste. Where food was covered, the quality of food was preserved and contamination avoided, hence the prevention of food waste.

The findings of the study supported a total of 13 indicators that contributed to the prevention of food waste within the storage and inventory control element of the University food service system.

6.5.8.4 Issuing

To prevent food waste at the issuing stage, a requisition form, indicating the needed ingredients (with product description), quantity and size according to the recipes, was used to requisition supplies from the store (O, D). This enabled effective monitoring of the stock, hence preventing food waste as only the required quantity for production was issued (Kinasz *et al*., 2015). Further, the exact quantity of food was issued from the store, as specified on an authorised food production plan (O, I, D). In this way, food products were only issued when needed for production. This allowed for accurate tracking of food items removed from storage with actual production requirements. Moreover, requested items were measured using appropriate measuring equipment (O, FG). This ensured that accurate quantities were issued thus avoiding food wastage, by not issuing more ingredients than required (Filimonau *et al*., 2020). Before production, food items issued were cross-checked against the standardised recipes to verify what was issued matched the ingredients on the recipes (O). This possibly contributed to preventing food waste as it avoided food surplus and the production of poor quality products, due to the use of ingredients or quantities not specified in the recipes. In some cases, the inaccurate measuring of ingredients resulted in a food surplus. Where unused ingredients were returned to the appropriate storage areas, food waste was prevented (FG, O).

The findings of the study supported a total of five indicators that contributed to preventing food waste at the issuing stage of the University food service system.

6.5.8.5 Production

The findings of the study demonstrated a number of mitigation strategies applied to reduce food waste at the food production stage. The University food service unit developed and used a production worksheet or production schedule, which contributed to preventing food waste (D, I). The production schedule indicated the menu items to be produced for the different meal times, the planned quantities, date and time the products were needed, the responsible chef and the actual yield. The production schedule was posted on the bulletin board, which served as an effective communication tool (**linking processes**) to the food production team. The schedule conveyed all the important information relating to the production of the food to be ready at the specified times. The use of a daily food production schedule was valuable as it assisted management with controlling the food production labour (**management function**) (D, I). The workload was balanced according to the assigned duties and the specific skills of the individual employee, which assisted management with a work-flow for all the production activities. This approach possibly ensured that the food items were prepared for the required times, while ensuring the accountability of the responsible food service workers for the quality of the food, hence this prevented food waste. This shows the interrelations between the functional subsystem, **inputs** (human resources) and **linking processes** (communication) and their impact on preventing food waste (**output**).

The overproduction of meals was the main cause of food waste generated at the production stage. To reduce its occurrence, a number of strategies were employed. As part of the ingredient control process, ingredients were measured using appropriate measuring equipment prior to the production of the various menu items (O, FG). This ensured that the ingredients issued were accurately measured according to the standardised recipes, which led to the production of good quality products and avoided wastage. In agreement with this, Gregoire (2017:158) indicated that measuring ingredients is an important component of quality and quantity control thus preventing food waste in food service operations.

To avoid food spoilage and to preserve food quality and safety, food items were thawed in the cold room at a temperature between 1 - 4ºC (O, FG). The participants of the study indicated that thawing raw frozen meats on the kitchen counter or under running water were not suitable methods. In accordance with the findings, Priefer *et al.* (2016) demonstrated that compliance with food safety standards, such as thawing principles, is an important practice. This not only keeps the food safe but reduces spoilage as the food does not pass through the temperature danger zone, thus preventing food waste. The literature further confirms that controlling the thawing process is an important factor in the quality of food as it avoids microbial multiplication, and avoids quality loss in terms of colour, water holding capacity and texture (Vibetti, 2012).

The findings of the study further revealed that the use of standardised recipes led to the production of good quality food products of the right and consistent quantities (FG, I, O, D). This is indicated in the comments below by some of the study participants:

> *"Adherence to the standardised recipes helps in attaining quality".*

Another mentioned that:

> *"The fact that our recipes are standardised, ensures that we get the exact quantities".*

In accordance with the findings, previous studies (Goonan *et al.,* 2014) have demonstrated that the use of standardised recipes reduced the amount of food waste during food preparation and production, as errors were minimised. Moreover, as mentioned by the study participants, the adherence to standardised recipes resulted in obtaining the specific, expected yield, which aided in the accurate forecasting of the meals to be produced and avoided overproduction. Additionally, adherence to standardised recipes ensured that the food was properly cooked and met the expected quality standards and minimised the chances of discarding food, due to poor quality (FG, I).

The preparation and cooking of food within the shortest time possible was a contributing factor to prevent food waste (I, FG). The studied food service unit applied three types of food service systems; the conventional, ready-prepared and commissary. With the conventional system, the food service unit prepared and cooked close to service time and then held the food in heated cabinets until time to serve. During service, the food was transferred from the heated cabinets to the bain-maries in the serving area of the cafeteria. Where cook-chill and cook-freeze systems were used, food was partially cooked, rapidly chilled or frozen, and then held in chilled or freezer storage. For the commissary food service system, food products were produced at the food service unit, packaged, held in cabinets at a temperature above 60ºC and immediately distributed to the remote kitchens. All these practices prevented exposure of food products to the temperature danger zone (I, FG, O). This possibly preserved the quality and safety of food products thus preventing food waste. In agreement with the findings, Betz *et al.* (2015) and Creedon *et al*. (2010) agreed that avoiding the exposure of food to the temperature danger zone after preparation, prevents food spoilage and microbial growth, which contributes to preventing food waste.

During the preparation and production of food using the cook-chill and cook-freeze systems, appropriate procedures were followed to preserve the safety and quality of the food. In the cook-chill system, food preparation and production were followed by rapid cooling to 3ºC within 90 minutes using a blast chiller, then refrigerated for use at a later time (O). In the cook-freeze system, the food was produced followed by rapid freezing and storage in a frozen state until needed (O). Even though these systems somewhat contributed to the generation of food waste, due to the loss of food quality, they also prevented food waste that might have occurred due to the overproduction of food. Excess food produced was treated using the cook-chill or cook-freeze methods, thus reducing food safety risks and preserving food for later use. In line with this, one of the participants noted that:

> *"Let's say production gives me six pans of lasagna, or actually I see them producing food and I can tell it's too much; I ask them to cook-freeze some and I take them in small batches depending on demand, so we don't have waste".*

Another approach to preventing food waste during production, are time and temperature control (D, FG, O). The participants stated that time and temperature were critical control elements that highly influenced the quality of food produced, hence affecting the generation or prevention of food waste. For example, the proper control of the temperature and length of time, while cooking steak, led to the production of good quality steak at the correct degree of doneness and with no excess moisture loss (O, FG). In the same way, the findings indicated that producing baked products, such as cakes at the right temperature and baking time, resulted in the production of high-quality products, while inaccurate time and temperature control, resulted in either sunken or cracked baked products. This indicates that time and temperature controls relate to the quality of food products and thus prevent the generation of food waste. The findings reflect those of Okumus *et al*. (2020), who found that in all-inclusive resorts, cooking food to the correct temperature maximised the quality of the food and reduced food waste. Further to that, according to Al-Kandari, Al-Abdeen and Sidhu (2019), the correct time and temperature control were important in preventing microbial growth in foods. Preserving the safety of food is an important factor in preventing food waste.

From a safety perspective, the University food service unit regularly checked and recorded the internal temperature of cooked meals (FG, O, D). Checking the internal food temperature and maintaining acceptable temperature ranges is critical in preventing food waste; this conserves the safety and quality of food, which possibly minimises the chances of spoilage and food disposal. In support of the findings, Mercier, Villeneuve, Mondor and Uysal (2017) indicated that the internal food temperature, food safety and food waste were linked; failing to maintain the acceptable internal temperature can stimulate the growth of pathogens and spoilage microorganisms and render the food product inedible. These findings supported the importance of checking and maintaining the acceptable internal food temperature in preventing food waste. At the end of each food production process, the products were evaluated (FG, I, O). The evaluation focused on the aesthetic factors of the food (D). The participants of the study indicated that product evaluation helped determine the acceptability of the food products by the food service workers and supervisors before the food was distributed to the customers. Where the acceptable level of food quality was not reached, the food was taken back to production to be modified thus reducing the likelihood of food waste, due to poor quality. The product evaluation process also involved recording information about the quality standards of the evaluated product on the required form. Such records (memory) served as a feedback mechanism that informed the University food service unit about the quality of the food products, and if the predetermined quality standards were not frequently met, the recipe standardisation process was revisited.

The findings of the study supported a total of 11 indicators that contributed to preventing food waste within the production element of the University food service system.

6.5.8.6 Distribution

The most common causes of food waste during distribution, were the abuse of time and temperature, which impacted the quality of food, as well as poor rethermalisation practices. Several measures were put in place to prevent food waste as a result of these causes. Where food was produced using the cook-chill or cook-freeze system, it had to be reheated after distribution and prior to service. When chilled or frozen food items, which were reheated in bulk, remained after service, these had to be discarded, since food could only be reheated once. However, certain practices in the rethermalisation system assisted in minimising food wastage. In cases where proper reheating procedures were followed, food waste was reduced (D, O, FG). This involved reheating food rapidly to at least 60ºC and serving the food immediately or placing it in the appropriate holding units. The food service personnel monitored the reheating process; checking the internal temperature of the food and ensuring that the appropriate temperature was reached (D). This ensured that food was safe to eat and reduced the chances of discarding the food, due to food safety risks, hence reducing food waste. Additionally, following proper rethermalisation retained the sensory quality of food thus increasing the chances of the food being acceptable to the consumers, which led to few leftovers from the service point (D, O, FG). Where reheating was done in small batches, food waste was minimised (O). Reheating food in bulk led to the chances of discarding excess food that may have been left over after service, as food safety plans did not allow the re-use of reheated food. Notwithstanding this, as discussed in Chapter 5, a considerable amount of food was wasted due to reheating in bulk. A few single pre-portioned special diet meals, which were cook-frozen and stored, were reheated in small quantities. Pre-portioning meals and reheating in small batches can possibly save a considerable amount of food.

The use of appropriate specialised meal distribution equipment with temperature controls, played an important role in preventing food waste (O, D, FG, I). In the case of the centralised delivery-service system, food items produced were held in hot and cold-holding equipment, which helped in the maintenance of the proper temperature thus preventing food waste (O, FG, I). Hot prepared food that was not consumed immediately, was held in heated cabinets above 57ºC (Figure 6.18)**.** Cold food items were held in refrigerated cabinets at a temperature of 5ºC and below (Figure 6.19). This practice ensured that food was within the safe temperature range, prevented food spoilages and retained the quality of food, hence reducing chances of discarding any food. The holding process was carefully monitored for time and temperatures (D, O). The temperature of food was regularly checked to ensure that the correct temperature was maintained, which minimised spoilage and reduced the risk of discarding food (Betz *et al*., 2015). Ross, Kemerer and Taylor (2006) confirmed that maintaining the proper temperature of food, prior to serving, is essential for controlling the growth of pathogenic bacteria. Ensuring the safety of food in turn minimises the chances of throwing away food.

FIGURE 6.18: HEATING CABINET USED TO HOLD HOT FOOD

FIGURE 6.19: REFRIGERATED SALAD BAR USED TO HOLD COLD SALADS AT THE UNIVERSITY OF PRETORIA

Where meals were produced at the central kitchen, a decentralised delivery-service system was used to distribute the food to satellite units at remote sites (commissary food service system) using insulated cabinets (Figure 6.20). The insulated cabinets retained the temperature of the meals, such that there was an insignificant difference between the temperature recorded before departure from the central kitchen and the one recorded upon delivery at the satellite food service units (D, O). In accordance with the findings, Thyberg and Tonjes (2016) demonstrated that the use of insulated cabinets for food distribution maintained the temperature of food thus preserving the safety and quality of food.

FIGURE 6.20: INSULATED CABINETS USED DURING FOOD DISTRIBUTION

Another factor, the maintenance of proper food temperatures during distribution, contributed to the prevention of food waste (D, O). Food temperatures were taken and recorded before the menu items left the central kitchen, upon delivery at the satellite food service units, prior to the start of service and periodically throughout service. This played an important role in ensuring the safety of the food served (Gregoire, 2017:202). The time taken to distribute the food was highly controlled and kept short (FG, I). This possibly minimised the chances of temperature abuse thus preventing food spoilage and food wastage.

A total of nine indicators that contributed to preventing food waste, were generated from the qualitative findings within the distribution element of the University food service system.

6.5.8.7 Service

Poor quality food at the service point resulted in rejection by the customers, which resulted in leftovers, some of which were discarded (Chapter 5). To prevent food waste as a result of this factor, the University food service operation applied several strategies. Upon receiving the food from the food production unit, the front-of-house staff checked the quality, considered the presentation, colour, texture, smell, taste, and food temperature, as indicated on the daily serving log sheet (D, FG, O). In line with this, some study participants highlighted that food quality and temperature checks were important measures in preventing food waste:

> *"…when the food comes from BOH I have to check them first and secondly I have to taste them. If the food is not well seasoned, I go to the production unit and find out who prepared the food and ask them to modify it before I sell to students so as to avoid complaints".*
>
> *"What we usually do is to check the temperature of food before service. I also taste the food before we serve them".*

Inspecting the quality of the food prior to service, allowed the University food service unit to rectify some quality issues, which minimised food waste that might have occurred, due to the non-acceptance of poor quality by the customers. Even though this is a popular standard of operation in the food service industry, the literature has not linked quality and temperature checks, prior to service to food waste prevention. A note of caution is due here, as not all menu items can be re-worked once the quality has been affected. It is therefore, advisable to put control measures in place that will ensure food quality and safety before the end of the food service system processes.

The study further found that portioning practices caused food waste at the distribution and service points. The portioning practices contributed to food waste in two ways; inaccurate portioning, and limited flexibility in the size of the portions served. In response to this, portion control measures were put in place (O, FG, D). Upon receiving the food from the production unit, the number of portions were counted, and the mass of the food served weighed for verification purposes (FG, O). This was further supported by the participants as illustrated below:

> *"You know for us in front-of-house we get food from back-of-house, when we get them, like if they gave us pork chops for example, we have a form in which we have to write the number of portions they gave us, and count them as well".*

This was an effective portion control strategy that increased the accuracy in portioning, as the front-of-house staff had to strike a balance between the number of portions received from production and the number of portions served. In this way, food wasted, due to poor portion control, was minimised. This finding has not been described in previous literature.

The University food service unit used standardised portion control utensils, such as colour-coded dishes, spoodles and ladles that increased the accuracy in portion control and reduced service waste. (O, FG, I). The importance of the use of standardised portion control tools in preventing food waste is indicated in the commentary below:

> *"We have portion guidelines and tools which prescribe to us how to portion, we have standardised serving spoons. We don't have the power to increase the portions".*
>
> *"We just do as we are ordered. If they say two spoons of rice, I serve two spoons".*
>
> *"… rice has its own scoop, gravy has its own scoop and vegetables have their own serving scoops. When it's a red scoop they make it full to the brim that is*

how we do it. If we have minced meat for example, we know we should have 20 portions from a pan and not less than that".

"… the use of serving spoons is helpful because otherwise serving staff would dish as they wish".

The comments clearly illustrate that adherence to the portioning guidelines and the use of standardised portioning tools reduced the amount of food waste during service. The comparison of the findings with those of other studies (Kinasz *et al*., 2015; Heikkila *et al*., 2016; Ofei *et al*., 2014) confirms that portioning accurately, using standardised serving tools, assists in preventing food waste. Despite the adoption of preventative portion controls, oversized portions and inconsistencies when serving food, were observed thus generating wastage. In accordance with this, Filimonau, Fidan, Alexieva, Dragoev & Marinova (2019) reported low popularity of portion control as an approach to food waste mitigation. This indicates the need to intensify strategies that control portioning and possibly link such strategies to the recommended dietary servings and nutritional standards. Additionally, the finding possibly suggests the need for more intense training and supervision in portion control guides, to ensure that proper tools and techniques are followed (Gregoire, 2017:188). In addition to this, a portion guide poster and manual (**communication**) to aid with accurate portioning by indicating portion sizes for all menu items and serving utensils could be mounted in a convenient location close to the serving area.

Other preventative approaches to the mitigation of food waste, were regular monitoring and the maintenance of the temperature of food throughout service (FG, O). Hot and cold holding equipment at the service point (bain-maries, chaffing chauffer dishes and heated and refrigerated cabinets, and salad buffets) were used to maintain appropriate temperatures (FG, O, I). As shown in Figure 6.21, the University food service unit had several serving points equipped with bain-maries and refrigerated cabinets. Figure 6.22 shows a display of food placed in bain-maries during service.

The internal temperature of food was measured and recorded upon receiving from the back-of-house, regularly checked and maintained throughout service, so that it did not fall within the temperature danger zone. It was ensured that the temperature of hot food was above 63°C or hotter and that cold food was at 5°C or below when served (O, D). In relation to this, food service workers confirmed that:

FIGURE 6.21: SERVICE POINTS EQUIPPED WITH BAIN-MARIES (University of Pretoria, 2014)
*Service points marked with stars

> *"At the serving point the temperatures are checked. There is a front-of-the-house checklist, I think that's also quality management".*

> *"When we receive food from BOH we check the food temperature using the probe to ensure it is at the appropriate temperature".*

> *"Bain-maries are cleaned when FOH staff arrive in the morning then they fill them with clean water. They then switch on the bain-maries to keep them hot. It's rare to receive complaints about food not being hot enough".*

The findings are consistent with that of Okumus *et al*. (2020), who indicated that the temperature of the food should be maintained, and hot and cold food should be served at the correct temperatures.

FIGURE 6.22: DISPLAY OF FOOD PLACED OVER BAIN-MARIES DURING SERVICE

To maintain the microbial and aesthetic quality of the food, it was kept covered whenever possible during service (O). Keeping the food covered appeared to contribute to preventing food waste as it retained the texture and colour of the food, prevented moisture loss, protected food from contamination, and possibly assisted in maintaining the temperature of the hot food. The linkage of this factor to preventing food waste has not been covered in the current literature.

A significant number of participants echoed that presenting meals attractively, both on the buffet and plate, prevented food waste (FG, I). It was observed that food displayed at the service point was served creatively with different colors and ingredients, such as tomato slices, julienne carrots and bell peppers and parsley used as garnishes. It is possible that presenting food attractively, attracted customers to purchase the well-presented menu items, hence reducing the amount of food remaining at the service point. This study supports evidence from previous research (Betz *et al*., 2015; Heikkila *et al*., 2016; Ofei *et al*., 2014) that found that attractive meal presentation had a role to play in curbing service waste.

As discussed in Chapter 5, the food waste generated, as a result of the overproduction of meals served in bulk that remained after service, was a concern. In response to this, the

University food service unit adopted good management and reuse of leftovers (FG, O, I, D). In line with this, food service workers commented that:

> *"When the food is left, we count everything, we find out how many portions are left and record them, and then we sell them again, we don't prepare food while these other ones are still available".*
>
> *"… let's say we have 6 pans of Hungarian stew left over, if we can't use it immediately, we call other units who will be able to use at least one pan of stew. So, what we do, first, we call other units who can be able to utilise the stew, then if they can't, we immediately freeze them for future use because if it is frozen within a reasonable time it is still okay for consumption".*

Figure 6.23 below, illustrates the leftover food was chilled for later use to prevent food waste.

FIGURE 6.23: LEFTOVER FOOD CHILLED FOR LATER USE

This is in agreement with the findings of the study conducted by Betz *et al*. (2015), who argued that proper management of leftover food by chilling or freezing within controlled times, avoided the multiplication of micro-organisms thus preventing food spoilage and reducing food wastage. The reuse of leftover food is a sound approach to preventing food waste that should, however, be applied with caution by adhering to strict food safety protocols.

A total of 11 indicators contributed to the prevention of food waste within the service element of the food service unit of the University food service system.

A total of 64 indicators were generated under the dimension of process and product design of the TQM practices. As illustrated in Figure 6.24 (next page), the process and product design component in the context of food service operations was viewed as activities undertaken under the functional subsystem.

In the next section, findings on sustainability practices that contributed to the prevention of food waste, are presented and discussed.

6.6 SUSTAINABILITY PRACTICES PREVENTING FOOD WASTE

This section presents how sustainability practices curbed food waste as applied in the University food service unit. The sustainability practices are categorised into food focused practices and environmentally focused sustainability practices.

6.6.1 Environment focused practices

The findings of the study demonstrated that a number of sustainable practices that are environmentally focused contributed to both the reduction of food waste in the food service system and potentially reduced the negative environmental impact. Specifically, reduced food mileage prevented food waste in the University food service system (I). According to the procurement supervisor, the transportation of food over a short distance retained its quality, especially fresh produce, thus reducing the possibility of food wastage from food spoilage. This finding is consistent with that of Frash *et al*. (2015) and Pearson *et al*. (2011). Additionally, it was indicated that in the event that poor-quality products were erroneously received, it was easy to return and replace them when they were sourced from a short food supply chain than if they were transported over a long distance. In this way food waste generated from the failure to reject poor-quality goods was reduced. This finding needs to be interpreted with caution because making frequent food deliveries may lead to a higher carbon footprint (Weber & Matthews, 2008).

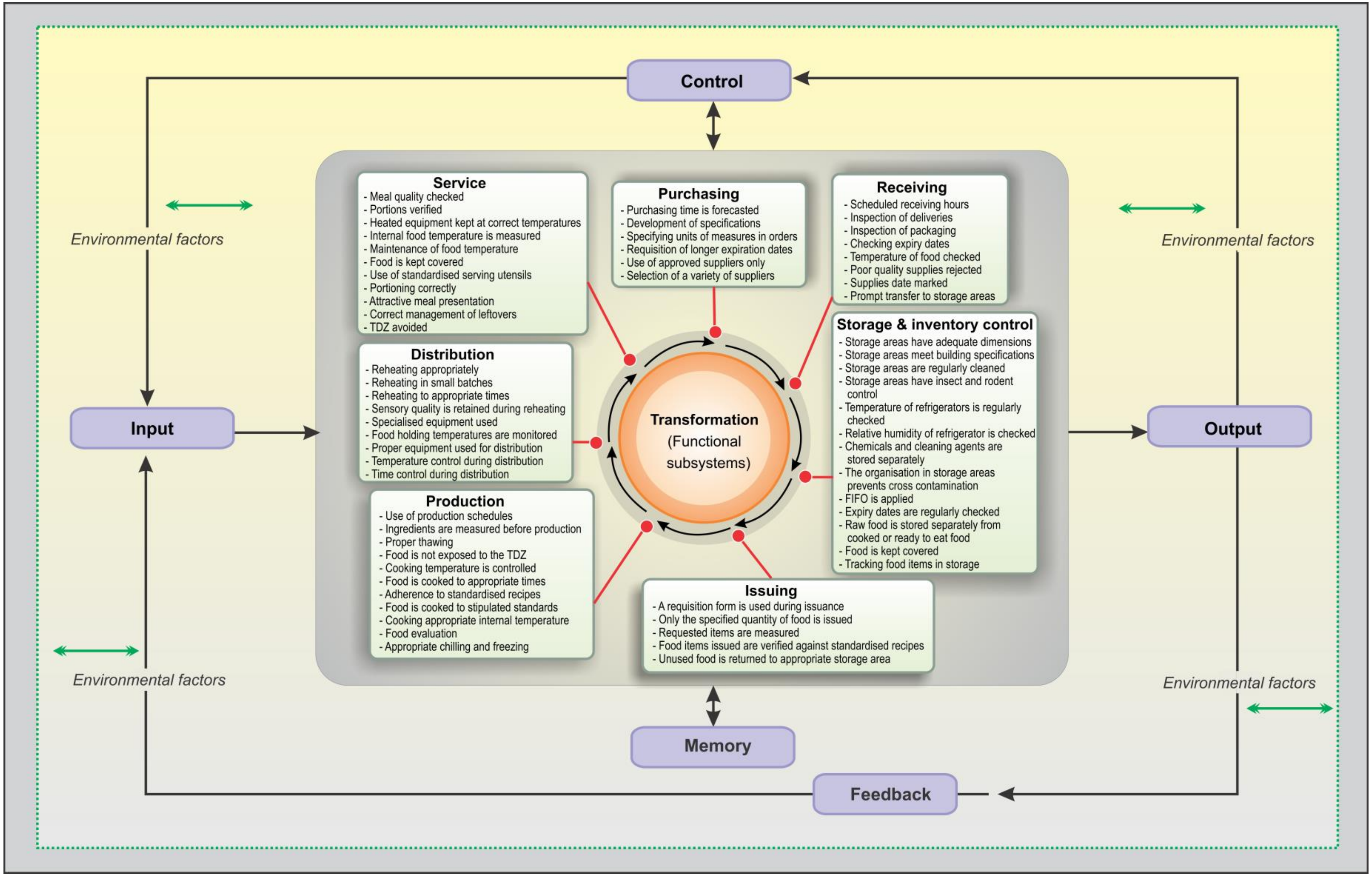


FIGURE 6.24: FOOD WASTE PREVENTION IN THE FUNCTIONAL SUBSYSTEM

The findings of the study further showed that energy conservation during cooking, such as switching off the cooking equipment a few minutes early such that the residual heat keeps cooking the food (O, FG, I). A possible explanation for this might be that such practices contributed to production of good quality food and avoided burning of the food, thus food waste prevention. The findings illustrated that batch cooking was a more energy efficient and environmentally friendly method than cooking to order on demand (FG, I). However, participants aired contradictory comments. One of the participants indicated that batch cooking prevented food waste as it allowed the food service unit to use ingredients that were about to expire and cook-chill or cook-freeze them for later use (FG). However, poor management of food cooked in bulk resulted in meals being discarded (FG).

Additionally, the findings demonstrated that the adoption of less energy consumption methods, such as blanching, steaming, frying and other quick production methods, had a role in the reduction of food waste (I, O). This may be explained by the fact that less energy consumption methods (quick production methods) allowed the University food service operation to prepare some meal items on demand (cook-to-order) thus preventing food waste due to overproduction. Additionally, adherence to the optimal cooking temperatures and times specified in the standardised recipes, contributed to reducing food waste as this assisted in producing good quality food items, avoided burning the food and ensured the safety of the food (FG, I, O).

Water efficient practices, such as the reduced use of running water, contributed to the prevention of food waste (I, FG, O). In the instances where food was thawed under running water, for example, the temperature, quality and safety of the food was tampered, which led at times to the wastage of the food. However, when thawing was done in the refrigerator, instead of under running water, the quality and safety of food was preserved, hence the prevention of food waste. In another activity, where rice was washed under running water, some was lost, whereas less rice was lost when it was washed in a bowl with collected water (O). Additionally, the use of just enough water for production as specified in the standardised recipes maintained the good quality of food items, hence the prevention of food waste (FG, O). In cases where more water was used than required, it was wasted, and the quality and consistency of the food was negatively affected, which contributed to food waste.

6.6.2 Sustainable food practices

Under this sub-facet, a number of factors contributed to preventing food waste in the University food service operation. The findings of the study illustrated that locally sourced ingredients contributed to preventing food waste, as they stayed fresh longer, as a result of the reduction in time associated with transportation (I). This finding corroborates the findings of the previous work by Frash *et al.* (2015) and Pearson *et al*. (2011). Sourcing local ingredients possibly had an influence on the time it took for the food product to spoil and the consequent food wastage. From an environmental standpoint, locally sourced foods are a potential solution to reduced food miles, which is linked to a reduced carbon footprint (Weber & Matthews, 2008). The use of food in season contributed to preventing food waste at the University food service unit (I). This is illustrated in the comment below:

> *"I cannot buy stuff that is not in season because that is terribly expensive, it tastes like nothing and thus easily generates waste".*

As indicated above by one of the participants, seasonal foods are of better quality and taste better, hence limiting food waste. The better quality and taste of seasonal foods may have the customers accept the menu items more readily, and before production the food will not spoil as easily. In accordance with the present findings, previous studies have demonstrated that seasonal foods have better quality, taste and are fresher than those produced out of season (Feagan *et al*., 2004). The findings of the study further demonstrated that the use of organic food generated less waste, due to the premium quality of these (I). However, purchasing organic food products was viewed as financially unfeasible. It is interesting to note that cooking to order or in small batches was found to be a contributing factor to preventing food waste (I, FG, O). This practice was particularly applied to food items that were quick to produce, such as fried chips, fried fish and Russian sausages. In line with this, food service workers agreed that cooking in small batches reduced food waste, as indicated in the following commentary:

> *"One of the strategies we put in place to cut on food waste is production of food in small batches".*

> *"When the chicken gets left towards end of service time, we can't ask the production team to produce more, we ask for fast items like fried fish to be produced as students wait".*

> *"When the food gets finished, like right now we have a box of fish at the back, and I am not going to take it out right now because if I take out fish they are going to order fish, they are not going to order pork chops and chicken strips so*

I wait for the available food to get totally finished. When the available food gets finished, we start preparing fish, we always tell them that fry 5, fry 6, the students rather wait for the fish to be prepared other than preparing 10 portions all at once because I am avoiding issues of explaining food waste".

"What is important to avoid waste is not cooking a lot of food all at once, it's best to prepare on demand. Like right now, just watch out from quarter past 2 until twenty past 2 or so, there aren't so many students, so I start producing food in small batches".

The cook-to-order system helped in the preparation of accurate food quantities thus curbing food waste from overproduction. However, this approach is not environmentally friendly as it consumes a lot of energy (Lewis *et al*., 2011).

The findings of the study did not support sustainable practices, such as the use of animal-welfare approved products, more plant-based menu items, and less animal-based items, as well as the reduction of processed foods. The study illustrated that customers liked and consumed more animal-based items, and most of the plant-based menu items, especially vegetables generated waste (O, FG, I). According to the study, the use of garnishes, to a limited extent, reduced food waste at the University food service unit (FG, I). Food garnishes were limited to the use of parsley or creatively using leftover ingredients. Comparing the findings with those of other studies, by limiting the use of garnishes, as these were often left uneaten, reduced food waste in restaurants (LeanPath, 2016). In this regard, the University food service unit rarely garnished food. It was further identified that the creative use of leftovers to make new menu items, reduced food waste (FG, O). An example includes the use of left-over mixed vegetables to prepare *chakalala* salad.

Figure 6.25 illustrates a summary of the sustainable practices that contributed to preventing food waste in the University food service system. These were conceptualised in an input-output model as shown in Figure 6.25 (next page).

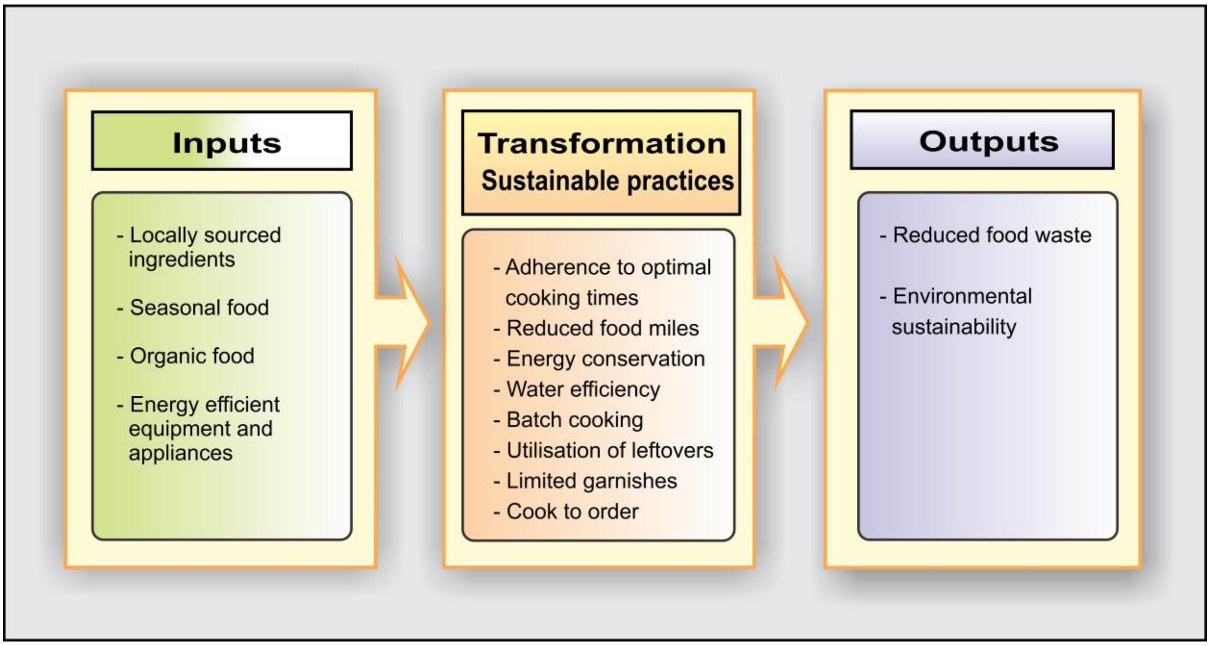


FIGURE 6.25: INPUT-OUTPUT MODEL OF SUSTAINABILITY PRACTICES AND FOOD WASTE PREVENTION

6.7 TQM PRACTICES, FOOD WASTE MANAGEMENT APPROACHES AND SUSTAINABILITY

As discussed in Chapter 5, the findings of the study showed that a considerable amount of food waste was generated at the University food service unit. However, strategies were put in place to avoid food waste occurring in the first place. The food waste management approach followed by the University food service unit as discussed in this chapter, falls within the first tier of the food waste hierarchy – i.e. prevention as illustrated in Figure 6.26. This is the most preferred food waste management approach, with the least negative impacts on the environment. As indicated by numerous literature sources (Dou *et al*., 2016; Garcia-Garcia *et al*., 2015; Mourad, 2016; Papargyropoulou *et al*., 2014; Priefer *et al*., 2016), the prevention of food waste benefits the environment and is the most sustainable food waste management option. The objective of this study was to explore how sustainable practices contributed to preventing food waste, and not to measure the extent at which practices were sustainable, this is an area that can be investigated in future research.

6.8 SUMMARY

Findings from the second phase of the study supported a total of eight dimensions of total quality management practices that were generated from the first phase. From the 46 indicators

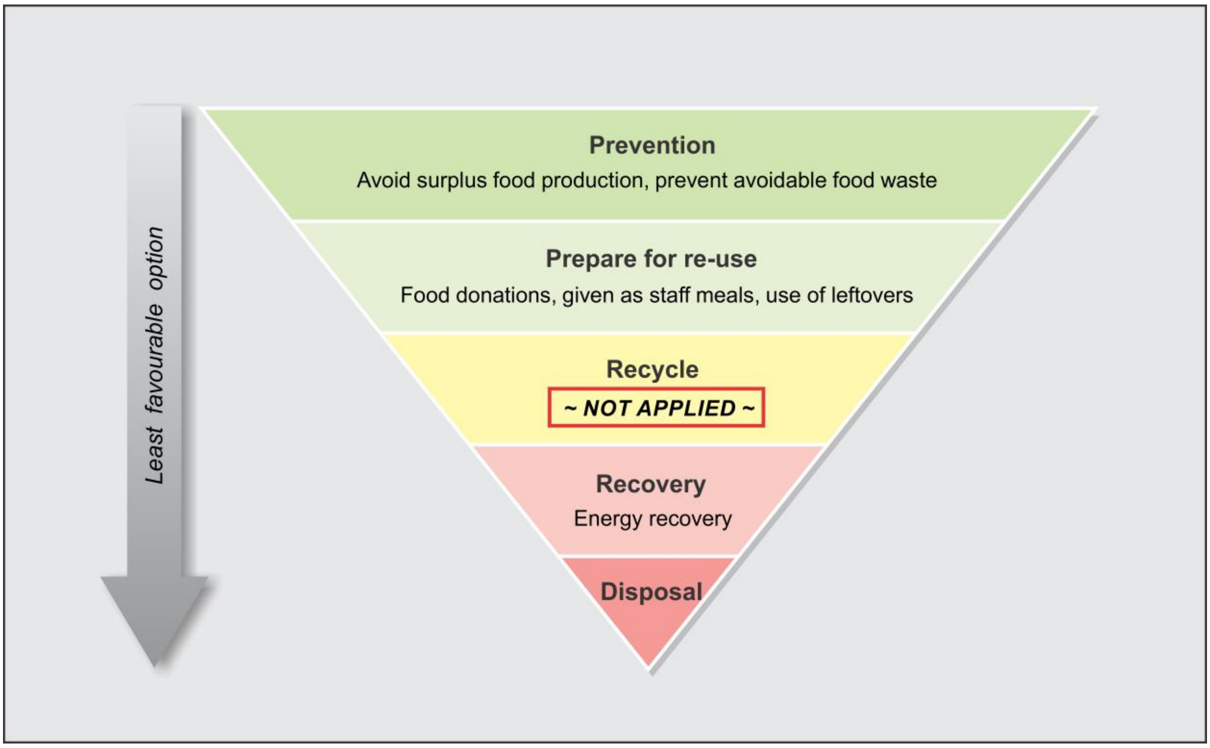


FIGURE 6.26: THE FOOD WASTE PREVENTION APPROACH APPLIED AT THE UNIVERSITY FOOD SERVICE UNIT

of TQM practices that were identified from the first phase, an additional 51 indicators were generated from the second phase, leading to a total of 97 TQM indicators at the end of the second phase. The qualitative findings focused on the environmental sustainability dimension, which were further categorised into two sub-facets; food-focused and environment-focused practices. A total of 12 sustainability practices (Figure 6.25 on previous page) that prevented food waste, were supported by the qualitative findings, and five indicators were eliminated, as they were not linked to food waste prevention. The TQM tool integrating sustainable practices to address food waste, which was refined from the second phase, was validated in the third and final phase.

Figure 6.27 (next page), illustrates total quality management practices (**control**) contributing to preventing food waste in the food service system. These practices ensured food quality and safety in all the aspects of the operations, thus preventing food waste, achieving the appropriate meals, quantity and quality, customer satisfaction, cost reduction and environmental sustainability (**outputs**). Records of the food service unit (**memory**) and **feedback** mechanisms were critical in providing information that was used to improve the quality of processes and products, and to reduce food waste.

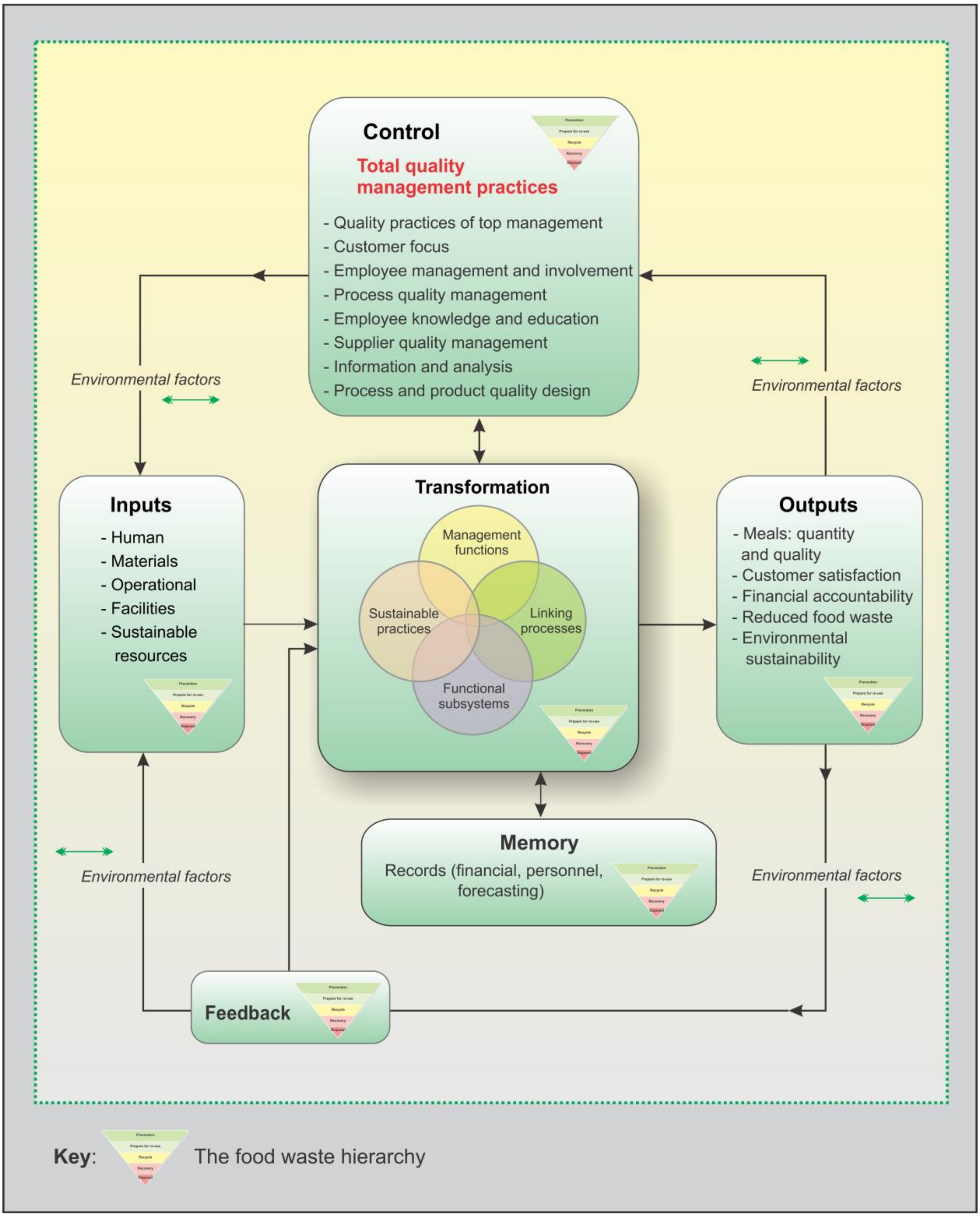


FIGURE 6.27: TOTAL QUALITY MANAGEMENT PRACTICES CONTRIBUTING TO FOOD WASTE PREVENTION IN THE FOOD SERVICE SYSTEM

Chapter 7:

VALIDATION OF A TOOL TO ADDRESS FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SECTOR

Chapter 7

VALIDATION OF A TOOL TO ADDRESS FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SECTOR

This chapter presents findings relating to the third objective, which was to validate the tool developed to address food waste in the University food service sector using the Delphi technique.

7.1 INTRODUCTION

This chapter will discuss the findings from both rounds of the Delphi process. First, a brief discussion of the modifications made from the findings of the pilot study is covered. The response rates of each round and the composition and demographic profile of the panellists of the Delphi process are described. The items or indicators that were added, removed or maintained by the expert panel members for each dimension are presented and discussed. Furthermore, the chapter presents the validated tool that was developed to address food waste in the University food service sector.

7.2 FROM THE PILOT STUDY TO THE FIRST ROUND SURVEY

Prior to conducting the Delphi survey, a pilot study was conducted to ensure the validity and reliability of the survey instrument. A total of 97 indicators of total quality management were generated from the second phase of the study (Addendum R). Further, a total number of twelve (12) sustainability practices were generated (Addendum R). These indicators were included in the first draft of the questionnaire that was piloted. Table 7.1 (next page) shows the number of indicators included in the first draft of the survey tool before piloting, the number of indicators added and eliminated after piloting. As indicated, a total of 19 total quality management practices were added from the piloting exercise, resulting in 116 indicators of TQM practices. Of the sustainability practices, one of the 12 indicators was deleted and thus 11 were included in the first phase of the Delphi survey. Conducting the pilot study also resulted in rephrasing some statements and instructions prior to implementing the Delphi survey.

TABLE 7.1: RESULTS OF THE PILOT PHASE

Components	Dimensions	*n* (indicators before piloting)	*n* (added indicators)	*n* (deleted indicators)	*n* (total indicators)
TQM Practices	Quality practices of top management	6	4	0	10
	Customer focus	5	0	0	5
	Employee management and involvement	5	4	0	9
	Process quality management	5	3	0	8
	Employee knowledge and education	3	3	0	6
	Supplier quality management	7	2	0	9
	Information and analysis	2	2	0	4
	Process and product quality design				
	Purchasing	6	0	0	6
	Receiving	9	0	0	9
	Storage and inventory control	13	1	0	14
	Issuing	5	0	0	5
	Production	11	0	0	11
	Distribution	9	0	0	9
	Service	11	0	0	11
	TOTAL NUMBER OF TQM INDICATORS	97	19	0	**116**
Sustainability practices	Environment focused practices	6	0	0	6
	Food focused practices	6	0	1	5
	TOTAL NUMBER OF SUSTAINABILITY INDICATORS	12	0	1	**11**

7.3 COMPOSITION OF THE DELPHI PANEL

The majority of the panel were female (n=8; 88.9%), with one (1) (11.1%) male. The vast majority of the panel were between 40 and 59 years of age (n=6; 66.6%). One (1) participant was aged between 30 and 39 (n=1; 11.1%) and two (2) (22.2%) were 60 years and above.

All panel members had a diploma/degree and above, with those holding either a Master's degree or PhD, were seven in total (n=7, 77.7%). Two (n=2, 22.2%) members held undergraduate qualifications (diploma and/or undergraduate degree).

TABLE 7.2: DEMOGRAPHIC INFORMATION OF THE DELPHI PANEL

Characteristic	*n*	%
Gender		
Male	1	11.1
Female	8	88.9
Age (years)		
30 - 39	1	11.1
40 - 49	3	33.3
50 - 59	3	33.3
60 +	2	22.2
Educational Background		
Undergraduate	2	22.2
Postgraduate	7	77.7

As shown in Table 7.3 below, there was a broad distribution of professional experience amongst the panel members. The experts were from academia, the research sector and the university food service segment. A third (33.3%, n=3) of the panel members were from academia (lecturers), and 44.4% (n=4) were from the University food service sector (three (3) food service managers and an administrative officer). One member was a manager in the University student residence placement and administration with a role to manage the University food service units. Additionally, one (1) member was a research scientist with expertise in food waste. Two members (n=2; 22.2%) had eight (8) years' experience, and another two (n=2; 22.2%) had experience ranging from 10-12 years. Two members (n=2; 22.2%) had 18-24 years' experience, and three members (n=3; 33.3%) had 30-36 years' experience.

TABLE 7.3: PROFESSION INFORMATION OF THE DELPHI PANEL

Area	Organisation	Job Position	Years of Experience
Academic	Tshwane University of Technology	Lecturer	30
	University of Pretoria	Lecturer	8
	Stellenbosch University	Lecturer	18
University Food Service	University of Pretoria	Food service manager	24
	University of Pretoria	Food service manager	12
	University of Pretoria	Administrative officer	36
	Private	Food service manager	36
University Student Residence	University of the Western Cape	Food service manager (placement & administration)	10
Research	Council for Scientific and Industrial Research (CSIR)	Research Scientist	8

7.4 DEVELOPMENT AND MEASUREMENT

The total quality management tool to integrate the sustainability practices, was developed in the second (developmental) phase of the study, based on the findings from the systematic review and qualitative case study. The tool was piloted before the actual Delphi survey. The tool included eight (8) dimensions of total quality management and two (2) of sustainability practices. As discussed above, a total of 116 indicators of total quality management practices, and 11 of sustainability practices were generated from the second (developmental) phase of the study and the pilot study. In the first round of the Delphi, the expert panel was asked to evaluate the importance of each of the components and indicators of total quality management and sustainability practices of food waste prevention (Wang *et al*., 2013). On a Likert scale of 1 to 5, the participants were requested to rate the importance of the items listed; 1 being the least important and 5 the most important. The participants were given an opportunity to add or modify items on the preliminary list. In Round 1, the level of agreement, standard deviation and interquartile range were used to measure the consensus of the indicators (Bentley *et al*., 2016). Indicators with a level of agreement of ≥ 80%, standard deviation of <1, and an interquartile range of ≤1 were considered to have reached consensus and agreement that these were important in reducing food waste. In Round 2, the level of agreement was used to measure the consensus of the indicators (Bentley *et al*., 2016). Indicators with a level of agreement of ≥ 80%, were considered to have reached consensus and agreement that these were important in reducing food waste. As discussed in Chapter 4, Section 4.17, in Round 2 of the Delphi survey, only the level of percentage agreement was used to assess consensus, as the sample size was too small. The small sample size increased the margin of error and decreased the statistical power in the application of standard deviation and interquartile range, hence the use of the percentage level of agreement only. The following section presents the findings and discussion from the first Round (Section 7.5.1) and the second Round (Section 7.5.2) of the Delphi.

7.5 FINDINGS AND DISCUSSION

In this section, the indicators where consensus was reached, as well as those that were deleted, modified and added throughout the Delphi process, are presented and discussed. The indicators where consensus was reached in the first round of the Delphi are discussed under Section 7.5.1 (Delphi round 1) and those that were included in the second run of the Delphi are discussed under Section 7.5.2 (Delphi round 2).

7.5.1 Delphi round 1

This section presents the response rate from the first round, and the indicators of total quality management and sustainability practices that reached consensus, as well as those that were deleted, modified and added in this round.

7.5.1.1 Response rate in Delphi round 1

From the 17 experts, who showed willingness to participate in the survey, only nine (9) completed it. This represents a 53% response rate from the first round.

7.5.1.2 Total quality management practices preventing food waste

The level of consensus and judgment of importance of total quality management practices from the first round of the Delphi is discussed in the following section. The discussion is according to each dimension of TQM practices.

- *Quality practices of top management*

As shown in Table 7.4, consensus was reached on a total of six (6) of the 10 (60%) indicators of the quality practices of top management in the first round of the Delphi survey, with a level of agreement of over 80% by the experts, a standard deviation of <1, and an interquartile range of ≤1. Consensus was not reached for four (4) of the 10 (40%) indicators and one (1) indicator was added. A total of five (5) indicators were thus included in the second run of the Delphi.

TABLE 7.4: LEVEL OF CONSENSUS ON THE IMPORTANCE OF QUALITY PRACTICES OF TOP MANAGEMENT ON FOOD WASTE PREVENTION

Indicators of quality practices of top management	Consensus (% agreement)	Standard deviation	Interquartile range
Management actively participates in quality improvement efforts.	88.9	0.707	1
Management holds regular meetings to discuss quality related issues.	88.9	0.667	1
Management supports quality improvement efforts by providing the necessary resources.	88.9	0.707	0.5
Food quality policy is taken into consideration in strategic planning.	**77.8**	0.782	1
Food quality data is taken into consideration in decision-making.	88.9	0.601	1
Food quality policy is communicated throughout the food service unit.	88.9	**1.000**	0.5
Management gives employees authority to manage food quality problems.	**77.8**	0.601	**1.5**
Management sets food quality strategies for employees.	**77.8**	0.928	0.5
Food quality results are evaluated to check improvements.	88.9	0.726	1
Management gives priority to food production processes.	88.9	0.726	0.5
Management liaises with personnel to get their input regarding quality policies and their implementation.	××	××	××

××Additional indicator suggested by panellists.

Looking at the detailed results in terms of key indicators where consensus was reached, it shows that the expert panel agreed that the active participation of management in quality improvement efforts is important in addressing food waste in the University food service system. This may be a reflection of the point noted by Li *et al*. (2003) that the commitment and participation of top management in quality improvement leads to successful implementation. The possible explanation is that the successful implementation of quality improvement efforts leads to the production of good quality menu items and subsequently, prevents food waste that may have otherwise occurred due to non-conformities (Kotsanpoulos & Arvanitoyannis, 2017). Management holding regular meetings gained consensus on the importance in preventing food waste. As discussed in Chapter 6, Section 6.5.1, staff meetings with management served as an important forum that allowed effective communication across different levels of staff, which resulted in collaborative efforts in developing and implementing food waste reduction strategies. The expert panel further agreed that provision of the necessary resources to support quality improvement was important in food waste prevention. Given the importance of the availability of **inputs** in the production of quality meals, in the right quantity, this finding is relevant in food waste prevention. As indicated in Table 7.4, it was agreed that taking food quality data into consideration in decision-making (**linking processes**) was an important factor in food waste prevention. From these results it is clear when making decisions that the consideration of the records (**memory**) on quality performance was important. Consideration of quality records can be interpreted as an important part of quality monitoring and evaluation that allows food service operators to identify deviations, hence to make deliberate decisions to address the identified root causes of such deviations.

The evaluation of the food quality results scored highly as an important factor in food waste prevention in the University food service system. This may suggest that analysing the results of quality indicators, including food product quality evaluation, allowed management to react to quality problems, develop control measures and corrective actions that ensure good quality food production. The evaluation of the food quality results to check improvements and correcting quality errors, exemplifies the concept of **dynamic equilibrium**. The results further indicated an agreement of the importance of giving priority to food production processes (**functional subsystem**) in preventing food waste. The production processes determine the quality of the food products produced (Gregoire, 2017:149). In this regard, prioritising production processes possibly leads to the production of quality food products, hence food waste prevention.

- *Customer focus*

Customer focus is an important part of the **feedback** element of the systems framework. In the first round of the Delphi study, a total of two (2) of five (5) of the indicators (40%) were interpreted as important in food waste prevention, the other three (3) failed to reach consensus (60%) (Table 7.5).

TABLE 7.5: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF CUSTOMER FOCUS ON FOOD WASTE PREVENTION

Indicators of customer focus	Consensus (% agreement)	Standard deviation	Interquartile range
There is a process of collecting customer feedback.	87.5	0.991	1
Customers are encouraged to submit complaints and proposals for quality improvement.	**62.5**	**1.126**	**2**
Customers' suggestions are taken into consideration for quality improvement.	87.5	**1.035**	1
Customers' suggestions are recorded and analysed.	87.5	**1.061**	1
Food service unit is in close contact with customers.	87.5	0.991	1
There is an open communication with customers.	××	××	××
Management of customer expectations.	××	××	××

××Additional indicator suggested by panellists.

Panellists suggested an additional two (2) indicators. A total of five (5) indicators were thus included in the second run of the Delphi.

The results indicated consensus on the importance of the availability of a process for collecting customer feedback on food waste prevention. This supports the discussion in Section 6.5.2, which indicated that the availability of customer feedback mechanisms, was an important strategy in curbing food waste at the University food service unit. In support of this, the literature (Heikkilä *et al*., 2016) elucidates that the availability of the customer complaints procedure allows food service operators to understand and react to customer complaints about such issues as poor-quality meals, unsatisfactory portion sizes, resulting in hence food waste reduction.

The findings further confirmed that close contact between the staff of the food service unit and the customers was important in curtailing food wastage, and improved the relations between the food service workers and customers. In this way, the food service unit gets an opportunity to better understand and respond to the changing needs of customers thus maintaining a **dynamic equilibrium**. In accordance with the present results, Heikkilä *et al*. (2016) indicated that interacting with customers is an essential aspect of quality improvement that leads to **customer satisfaction** (output), hence a reduction in food waste.

- *Employee management and involvement*

From the systems' perspective, employee management and involvement are part of the **management function** in the transformation process. Under the employee management and involvement dimension, five (5) of the nine (9) indicators (55.6%) reached agreement and were viewed as important in food waste prevention, during the first round of the Delphi. Four (4) indicators (44.4%) did not reach consensus in the first round of the Delphi and three (3) additional indicators were suggested as being important in food waste prevention (Table 7.6). Panellists suggested an additional three (3) indicators.

As illustrated in Table 7.6, the results indicated that the participation of food service workers in quality improvement was important in preventing food waste (100% agreement). Such participation may mean actively participating in the processes of continuous food quality improvement, participation in standardisation of recipes and portion sizes, analysing food quality performance and suggesting or implementing improvement measures. This may result in improving the quality during the process of production and thus food waste prevention. According to Fuentes *et al*. (2006), participation by employees improves the quality of products through self-inspection and solving quality problems immediately they occur, hence decreasing wastage.

TABLE 7.6: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF EMPLOYEE MANAGEMENT AND INVOLVEMENT IN FOOD WASTE PREVENTION

Indicators of employee management and involvement	Consensus (% agreement)	Standard deviation	Interquartile range
Employees who improve food quality are rewarded.	**62.5**	**1.035**	**1.75**
Employees are evaluated on how well they ensure food quality.	**75.0**	0.641	0.75
Employees participate in food quality improvement activities.	100	0.535	1
Employees are motivated to improve food quality performance.	100	0.518	1
Systems exist for promoting teamwork across the food service system.	**75**	1.356	**1.75**
Approaches to work promote open communication between departments and food service units.	**75**	1.458	**1.75**
Employees take initiatives during their work processes to solve problems that would impact on food quality.	87.5	0.991	1
Employees' suggestions on food quality assurance are adopted.	88.9	0.463	0.75
Employees recognise superior quality performance.	87.5	0.744	1
Change management of personal attitudes of employees towards quality management and waste.	××	××	××
Employees are provided with feedback on performance to encourage continuous improvement.	××	××	××
Job description in terms of food quality is clear.	××	××	××

××Additional indicator suggested by panellists.

Panellists also agreed that motivating employees to improve food quality performance was important in preventing food waste (100% agreement). This may be an indication that staff motivation is an important driving force in the attainment of organisational goals and objectives, including improved quality performance and food waste reduction. The body of research has shown that employee motivation has an influence on attitudinal factors, such as job satisfaction (**output**) and behavioural consequences, such as employee performance (Zheng, Zhu, Kim & Williamson, 2020). The implication is that motivating employees to improve quality performance may lead to employee satisfaction and encourage staff to ensure good quality throughout the food service system, hence preventing food waste. In accordance with this, a study conducted in the context of food service revealed that where managers motivated and encouraged staff members, staff duties were conducted professionally and to the best of their ability, which led to the control of food waste generation (Heikkilä *et al*., 2016).

It was agreed that employees who take initiatives to solve problems during their work procedures would have an impact on food quality and contribute to food waste prevention. According to research (Goonan *et al*., 2014), empowering food service employees to take initiatives during food production and service, increases their responsibility to reduce and manage food waste. Additionally, panellists agreed that adopting employees' suggestions on food quality assurance was important in preventing food waste. According to the total quality management literature (Beraldin, Danese & Romano, 2020), the use of an employee suggestion system plays an important **feedback** role and motivation function in any organisation, which helps increase efficiency, improves quality and thus eliminates waste. A study conducted by Ceryes, Antonacci, Harvey, Spiker, Bickers and Neff (2021) indicated that where management was unreceptive of employees' suggestions, food waste was generated. This exemplifies the importance of employee suggestions in food waste prevention. The findings further revealed that the recognition of superior quality performance was an important factor in preventing food waste. In support of this, Joiner (2007) illustrated that when employees feel acknowledged by the organisation and work colleagues, they improve the implementation of quality strategies, which possibly eliminates food production errors, hence reducing food waste generation.

- *Process quality management*

The results indicated an agreement on the importance of six (6) of the eight (8) indicators (75%) of process quality management (Table 7.7). Two (2) indicators (25%) failed to reach consensus and two (2) additional indicators were suggested.

By far the strongest area of agreement under the process quality management dimension, was determination and evaluation of the critical processes. These results may be explained by the fact that determining and evaluating critical processes may allow the food service operations to determine value-adding and non-value adding activities, hence the opportunity to eliminate activities that lead to poor quality and waste generation. The literature (De Steur, Wesana, Dora, Pearce & Gellynck, 2016) indicates that value stream mapping, a system that is inherent of evaluation of critical processes, helps in identifying food losses and waste generated through defects, unnecessary inventory, overproduction and inappropriate processes. Similarly, panellists agreed that the determination of areas, processes and points for improvement were required to control the critical processes and are important in food waste prevention. In this way error-free food production may be ensured, thus eliminating food waste.

TABLE 7.7: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF PROCESS QUALITY MANAGEMENT IN FOOD WASTE PREVENTION

Indicators of process quality management	Consensus (% agreement)	Standard deviation	Interquartile range
Process non-conformities are detected through internal audits.	**75**	0.991	**1.5**
Critical processes are determined and evaluated.	100	0.518	1
Determination of areas, processes and points for improvement.	100	0.535	1
Specific organisational structures have been formulated to support quality improvement.	87.5	0.991	1
All employees are provided with work instructions.	87.5	0.756	1
Mistakes are precluded in the process design.	87.5	0.707	1
Benchmarking of quality management practices.	87.5	0.707	1
Setting ranges within which non-conformities are tolerated or allowed.	**62.5**	**1.126**	**2**
Hazard Analysis and Critical Control Points (HACCP) system is put in place.	××	××	××
Good manufacturing practices (GMPs) are put in place.	××	××	××

××Additional indicator suggested by panellists.

The results further indicate that the formulation of specific organisational structures to support quality improvement was imperative in food waste prevention. As discussed in Section 6.5.4, the case study demonstrated that the formulation of a recipe development and review committee, contributed to quality improvement and food waste reduction. In agreement with this, Marais *et al*. (2017) illustrated the importance of the formulation of organisational structures that are inclusive of catering personnel in food waste prevention. The expert panel members reached consensus on the importance of the provision of work instructions to all employees in food waste prevention. This validates the findings from Section 6.5.4, which illucidated that providing food service workers with clear, written and oral work instructions that specified expected outcomes reduced the generation of food waste. In addition to this, precluding mistakes in the process design was agreed to be an important factor in the prevention of food waste. This concept, often referred to as 'mistake-proof design', implies that mistakes that may occur in the transformation subsystem are detected and prevented, so as to minimise food production errors thus reducing food waste generation. This concept has been widely applied in the manufacturing and construction industry and proved to be an effective approach that ensures quality and waste reduction (Prasad, Dhiyaneswari, Jamaan, Mythreyan & Sutharsan, 2020; Sadri, Taheri, Azarsa & Ghavam, 2011; Siegel, Antony, Garza-Reyes, Cherrafi & Lameijer, 2019). Panellists further indicated that benchmarking of quality management practices was an important factor in food waste prevention. The possible explanation for this is that the benchmarking process may allow a food service operation to compare its products, services, processes and practices against those of the best operations in the industry thus giving insight to the areas that need to be improved. The improvement of quality in such areas may curtail food waste generation. In support of this, the literature indicates that benchmarking enables organisations to better understand the gap between the ideal and current statuses of quality management systems (Yaseen, Sweis, Abdallah, Obeidat & Sweis, 2018). From these comparisons, food service organisations may discover and apply best practices, hence quality improvement, which may reduce food wastage.

- *Employee knowledge and education*

From the systems' perspective, employee knowledge and education is a part of the **management function** in the transformation process of the food service system. Under this dimension, only two (2) of the six (6) indicators (33.3%) reached agreement in the first run of the Delphi and were viewed as important in food waste prevention (Table 7.8). Four (4) indicators (66.7%) did not reach consensus and two (2) additional indicators were suggested as important in food waste prevention.

TABLE 7.8: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF EMPLOYEE KNOWLEDGE AND EDUCATION ON FOOD WASTE PREVENTION

Indicators of employee knowledge and education	Consensus (% agreement)	Standard deviation	Interquartile range
Qualifications of employees are evaluated for relevance with food service.	**77.8**	**1.118**	1
Employees have experience in food service.	**77.8**	0.782	**1.5**
Employees have the knowledge and know-how related to food service.	88.9	0.707	1
Employees are trained on topics with regard to their specialty and daily work in different areas of food service.	**77.8**	**1.054**	**1.5**
Employees are offered quality-orientated training.	88.9	**1.000**	1
Resources are provided for staff training.	88.9	0.726	1
Training newly appointed staff members prior to assumption of duty.	××	××	××
Training employees in all control measures to minimise waste.	××	××	××

××Additional indicator suggested by panellists.

The results of the study indicated a strong agreement on the importance of employees' knowledge and know-how related to food service in addressing food waste. This confirms the findings of the qualitative phase of the study, which indicated that employees' knowledge and technical proficiency, gained through work experience at the University food service unit, contributed to the production of good quality meals and the reduction of food waste. These results reflect those of Ko and Lu (2020), who also found that professional competence of kitchen staff was related to improved quality performance and good practices around food waste prevention. However, Kasavan, Mohamed and Halim (2018) stressed that even though the knowledge of workers is important in food waste prevention, positive attitudes and behavioural intentions are needed to increase workers' commitment towards addressing wastage. Panellists agreed that the provision of resources for staff training was an important factor in preventing food waste. This might imply that the provision of resources, as enablers for staff training might be important in ensuring that workers undergo both in-service and long-term training. In this way, the knowledge obtained from such training can be applied to produce quality food products thus curbing food wastage.

- *Supplier quality management*

Supplier quality management is an important aspect of TQM that supports the **controls** of the food service system. The results of the study indicated an agreement on the importance of seven (7) of the nine (9) indicators (77.8%) of supplier quality management (Table 7.9). Two (2) indicators (22.2%) failed to reach consensus and two (2) additional indicators were suggested. These were included in the second run of the Delphi and will thus be discussed under the Round 2 discussions.

TABLE 7.9: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF SUPPLIER QUALITY MANAGEMENT ON FOOD WASTE PREVENTION

Indicators of supplier quality management	Consensus (% agreement)	Standard deviation	Interquartile range
There is a solid partnership with suppliers.	87.5	**1.035**	1
Adherence of suppliers to food quality specifications.	100	0.354	0
Suppliers comply with requested food expiry dates.	87.5	0.744	1
Suppliers provide food quantities ordered.	100	0.518	1
Suppliers comply with the transportation standards for perishable and non-perishable foods.	100	0.518	1
Timely delivery of food products by suppliers.	87.5	0.744	1
Monitoring and assessing quality performance of suppliers.	100	0.535	1
Open communication between the food service unit and suppliers.	100	0.535	1
Written documentation from supplier that quality management procedures and legislation are adhered to.	**75**	**1.309**	**2.5**
Supplier delivery equipment is frequently inspected.	××	××	××
Suppliers use packaging materials that provide adequate protection of food during transportation.	××	××	××

××Additional indicator suggested by panellists.

Panellists strongly agreed that the adherence of suppliers to food quality specifications was important in preventing food waste. This validates the findings from the second phase, which illustrated that strict adherence of suppliers to specifications enabled the University food service unit to procure good quality products, which was critical in producing quality menu-items, hence preventing food waste. This finding is contrary to previous studies (Falasconi *et al*., 2015), which suggested that rigid food specifications increase the food waste problem. The difference may be attributed to the level at which food waste is generated in the food supply chain. While specifications may generate food waste for the supplier that may be the result from the rejection of poor-quality products, it reduces waste for the food service unit, as poor quality products are not acceptable.

The results further indicated agreement on the importance of complying with requested food expiry dates. A possible explanation is that compliance with requested expiry dates allows food service operations to better manage inventory, hence the reduction in food spoilage incidences. This study supports evidence from previous observations, which indicated that compliance with requested food expiry dates by suppliers assisted in food waste prevention that could have resulted from food spoilage (Betz *et al*., 2015). It was also agreed that with the suppliers providing the right quantity of food products, according to what was ordered by the food service operators may lessen the chances of overstocking and therefore, reduced food wastage. This validates findings from the second phase.

Another indicator; the timely delivery of food products by suppliers, was viewed as an important factor in food waste prevention. As discussed in Chapter 6, Section 6.5.6, timely deliveries as per the delivery schedule agreed between the supplier and food service operators, enabled the food service unit to plan for deliveries and obtain food products at such periods that would not lead to higher than required inventory levels. In this way, proper receiving of food and storage, and avoidance of overstocking were ensured, hence food waste prevention. The results further showed consensus on the importance of monitoring and assessing quality performance of suppliers. This result may be explained by the fact that the monitoring and assessment of quality performance of suppliers may enable the food service operations to identify quality gaps and ensure that suppliers meet the expected quality standards, hence supplying good quality products. The supply of good quality products may ensure the production of good quality products thus preventing food waste. This aspect has not been documented in the current literature. The expert panel further agreed that open communication between the food service units and suppliers was an important element in food waste reduction. The result also validates the findings from the second phase of the study.

From the systems perspective, open communication is part of the **linking processes** of the transformation element of the food service system. Effective communication between suppliers and food service operators is important in preventing food waste, for example, complaints communicated to suppliers about incorrect deliveries, and the delivery of poor quality food products results in corrective measures taken to rectify complaints, which curtails food wastage. In agreement with the findings, Heikkilä *et al*. (2016) reported that effective communication between suppliers and food service operators is an important element in food waste prevention.

- *Information and analysis*

From the systems' perspective, information and analysis is viewed as the **memory** element, as it dealt with the collection and analysis of information from both the internal and external environments. As shown in Table 7.10, only one (1) of four (4) (25%) indicators of information and analysis reached consensus in the first round of the Delphi survey, with a level of agreement of over 80% of the experts, a standard deviation of <1, and an interquartile range of ≤1. Three (3) of the four (4) (75%) indicators failed to reach consensus and four (4) additional indicators were suggested. A total of seven (7) indicators were included in the second round of the Delphi survey.

TABLE 7.10: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF INFORMATION AND ANALYSIS ON FOOD WASTE PREVENTION

Indicators of information and analysis	Consensus (% agreement)	Standard deviation	Interquartile range
A variety of data collection methods are used to ensure reliability of quality performance data.	**75**	0.756	**1.5**
There is adequate storage for archiving information.	**37.5**	0.916	**1.75**
Easy retrieval of stored information.	**75**	0.886	**1.75**
There is systematic analysis of food quality data.	87.5	0.756	1.00
Accurate data recording.	××	××	××
Information is readily available for analysis at any given time.	××	××	××
Analysed data is used to influence decisions.	××	××	××
Systems for tracking food waste and surplus are available.	××	××	××

××Additional indicator suggested by panellists.

As indicated in Table 7.10, the panellists agreed on the importance of the systematic analysis of the food quality data. According to the literature on total quality management, the systematic analysis of data is considered an important part of fact-based decision-making in any organisation (Black and Porter, 1996). The systematic analysis of quality data may provide food service operators with important information about the quality performance of processes within the food service system, hence enabling them to make informed decisions and to respond satisfactorily to inadequacies. Such a response may lead to good quality food production and service, hence food waste prevention. The results are consistent with that of Mosadeghrad (2014), who indicated that the systematic analysis of data allows organisations to identify customer requirements, determine areas, processes and points for improvement, and establish the cause of quality problems. This will influence the success of quality improvement to cut down on wastage that could occur due to poor quality. Sadikoglu and Zehir (2010) also demonstrated that the systematic analysis of data informs the organisations about the rate of defects, defective products and non-conformities, so that corrective actions can be taken to avoid the repetition of past mistakes. In this way, the analysis of data provides the food service organisation with **feedback**, which is important in maintaining **dynamic equilibrium**.

- *Process and product quality design*

This section will discuss the indicators where agreement was reached, under each stage of the functional subsystem of the food service system.

⇒ *Purchasing*

Five (5) of the six (6) indicators (83.3%) of purchasing (Table 7.11) were identified as important in food waste prevention. For one (1) of the indicators, consensus was not reached during the first round but reached in the second round of the Delphi. One (1) additional indicator was suggested in the first round of the Delphi but this failed to reach consensus.

TABLE 7.11: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF PURCHASING ON FOOD WASTE PREVENTION

Indicators of purchasing	Consensus (% agreement)	Standard deviation	Interquartile range
The expected amount of time before a food item should be purchased is forecasted.	**75**	0.991	**1.5**
Food specifications are developed.	100	0.518	1
Units of measure are specified in purchasing orders.	100	0.535	1
Particular expiry dates are requested when purchasing food items.	87.5	0.991	1
Only approved suppliers of food are selected.	87.5	0.756	1
Select and establish a variety of suppliers to ensure supply options.	87.5	0.707	1
Changes in the menu are communicated in time to optimise ordering.	××	××	××

××Additional indicator suggested by panellists.

There was strong agreement that the development of food specifications was important to prevent food waste. A possible explanation may be that food specifications serve as an important tool in managing the quality levels of food products purchased and absorbed by the food service unit. Food products that do not meet the stipulated quality specifications are rejected by food service operations. This may enable the food service units to produce good quality food products, and so minimise the chances of discarding food due to poor quality. These results reflect those of Charlebois *et al*. (2015), who also found that the development and adherence to food specifications ensured that food service units obtained good quality products thus preventing food from possible spoilage or poor quality menu items. However, the literature (De Hooge, Van Dulm & Van Trijp, 2018) illustrates that food specifications contribute considerably to food waste across multiple supply chain levels. Panellists also agreed that specifying units of measurement when purchasing orders was important in food waste prevention. As discussed in Chapter 6, Section 6.5.8.1, this ensured that the right products were ordered and correct quantities delivered. In this way, food waste was prevented as only those deliveries matching the purchase order were received thus avoiding overstocking.

As indicated in Table 7.11, the requisition of food products of particular expiry dates when purchasing was viewed as an important factor that contributed to food waste reduction. This means that there might be a greater opportunity to minimise food waste due to spoilage or expiry when food products purchased have a reasonable long shelf life. Comparing the findings with those of Betz *et al*. (2015), it confirmed that requesting the supply of perishable foods with a sufficiently long shelf life helped prevent food waste. Notwithstanding this, the literature indicates that the relationship between a longer shelf life and food waste reduction is not straightfoward. For example, complex factors, such as inventory turnover and order size suggests that a longer shelf life may not guarantee consumption before products have reached expiry date (Eriksson, Strid & Hannson, 2015). The panel of experts also considered the selection of food from approved suppliers important to prevent food waste. The selection of approved suppliers is possibly a critical part of food safety, traceability of food products and quality assurance. These aspects have the potential to affect the lifetime of food products and the quality of final menu items, hence a possible influence on food waste generation. The selection and establishment of a variety of suppliers so as to widen the supply options was identified as an important indicator in food waste prevention. As discussed in Section 6.5.8.1, a wide option of suppliers prevented food waste in that if one supplier failed to meet the quality standards, another could be selected so as to not compromise food quality. Additionally, if a supplier did not have the required food products in stock, another was considered, which ensured the availability of menu items in the quantity and quality promised to the customer, hence **customer satisfaction**.

⇒ *Receiving*

As indicated in Table 7.12, panellists were in agreement on the importance of eight (8) of nine (9) indicators (88.9%) for the receiving of food items for the food service system. One (1) indicator failed their consensus and it was included in the second run of the Delphi.

TABLE 7.12: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF RECEIVING ON FOOD WASTE PREVENTION

Indicators of receiving	Consensus (% agreement)	Standard deviation	Interquartile range
There are scheduled hours for receiving.	**75**	0.756	**1.5**
Deliveries are inspected for quantity, against purchase order and invoice.	100	0.463	0.75
Deliveries are inspected against quality specifications.	100	0.518	1
Deliveries are checked to ensure undamaged packaging.	100	0.518	1
Expiry dates of deliveries are checked.	87.5	0.744	1
Temperature of perishable food is checked upon delivery.	100	0.463	0.75
Food items that do not meet quality specifications are rejected.	100	0.463	0.75
All newly received food items are date marked.	100	0.535	1
Received food items are promptly transferred to appropriate storage areas.	100	0.354	0

It was agreed that the inspection of deliveries against purchase orders and invoices was important in food waste prevention at the University food service level. This is an important process in receiving as it verifies that the correct quantity ordered was delivered thus avoiding losses or overstocking. It was further agreed that the inspection of deliveries against quality specifications was an important contributor to food waste preventionPrior studies (Charlebois *et al*., 2015) noted the importance of the inspection of deliveries to ensure the quality. Products may be rejected due to supplier noncompliance with quality requirements, such as visual and quality defects, including misshapened, blemished, and wrong-sized foods (Kulikovskaja & Aschemann-Witzel, 2017). In this way food waste is prevented in that poor quality products that may lead to the production and service of poor quality menu items, are rejected at the time of delivery.

Food that is delivered in a damaged shape or form, or in damaged packaging, is another contributor to food waste. It was important to check deliveries to ensure undamaged packaging, as this is the first indicator of good quality and food safety. If a product is delivered in a damaged packaging, an inspection will help pick up the problem; such a product will be rejected so that the food service unit does not absorb waste from the supplier (Filimonau *et al*., 2020). Checking expiry dates of delivered food products was viewed as an important practice in food waste prevention. The expiry date or the best-before date or sell-by date of packaged foods have an influence on the safety, spoilage and quality of food products. Comparing the findings with those of other studies (Charlebois *et al*., 2015; Pirani & Arafat, 2014) confirms that inspecting and rejecting food products that have expired or will soon be out-of-date reduces food wastage due to spoilage. Panellists further agreed that checking the temperature of perishable food items was important in preventing food waste. In accordance with the present results, previous studies (Bilska *et al*., 2020; Kantor *et al*., 1997) have demonstrated that checking the temperature of perishable and refrigerated food deliveries contributed to reducing food waste, as food products with signs of temperature misuse were rejected as microbial growth or spoilage could have occurred.

It was agreed that labelling and date marking all newly received food products, contributes to food waste reduction. As discussed in Section 6.5.8.2, labelling the received food products assisted in better inventory management and minimising food spoilage and waste (Ghanem, 2020). The strongest level of agreement is for the importance of immediately transferring the received products into the appropriate storage places to prevent food waste. This practice is important in preventing spoilage and any deterioration that may occur, especially if refrigerated, frozen or perishable products are held at room temperature for any period of time (Engström & Carlsson-Kanyama, 2004).

⇒ *Storage and inventory control*

As indicated in Table 7.13, consensus was reached for 13 of the 14 indicators (92.9%) in the first run of the Delphi. One (1) indicator failed to reach consensus and was included in the second round of the Delphi survey.

It was agreed that storage areas that meet the specifications for walls, ceilings, floors, windows, baseboards, floor drains, lightning and ventilation contributed to the reduction of food waste in food service units. According to the literature (Beretta *et al*., 2013; Betz *et al*., 2015; Marthinsen *et al*., 2012; Rostami *et al*., 2020) storage areas that meet these building requirements, maintain the appropriate temperature and humidity thus preventing food spoilage.

TABLE 7.13: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF STORAGE AND INVENTORY CONTROL ON FOOD WASTE PREVENTION

Indicators of storage and inventory control	Consensus (% agreement)	Standard deviation	Interquartile range
Storage areas have adequate space for storing all food-related items.	**75**	0.756	**1.5**
Storage areas meet specifications for walls, ceilings, floors, windows, baseboards, floor drains, lightning and ventilation.	82.5	0.707	1
Storage areas protect food from direct sunlight, heat, moisture and smoke.	100	0.518	1
Storage areas are regularly cleaned.	100	0.354	0
Storage areas have insect and rodent control.	87.5	0.756	1
Temperature of refrigerators is regularly checked.	100	0.354	0
Chemicals and cleaning agents are stored separately from food items.	87.5	0.756	1
The organisation of food items in storage areas prevents cross-contamination.	87.5	0.744	0.75
The FIFO (First-In, First-Out) rotation system is applied at all times.	100	0.463	0.75
Expiry dates of food items are regularly checked.	100	0.518	1
Raw food is stored separately from cooked or ready-to-eat food.	87.5	0.756	1
Food is always kept covered.	87.5	0.756	1
A continuous track is kept of food items held in storage.	100	0.518	1
Relative humidity of refrigerators is regularly checked.	87.5	0.744	1

The panellists agreed on the importance of storage areas that protect food from direct sunlight, heat, moisture and smoke, in food waste prevention. Prolonging or maintaining the shelf life of food products requires storage facilities that protect food against these elements. According to the literature (Chalak, Abou-Daher & Abiad, 2018), direct sunlight promotes oxidation and subsequent loss of food quality. Heat or improper storage temperatures lead to quality-loss, drying-out, promotion of microbial growth, and hasten food spoilage (Bharucha, 2018). The exposure of food to moisture increases the growth of microbes and can lead to the caking of dry ingredients. Storage facilities that protect food from these conditions minimise microbial growth, retain the quality of food and prevent food spoilage, hence food waste reduction. It was further agreed that storage areas that are regularly kept clean contributed to food waste prevention. As discussed in Section 6.5.8.3, clean storage areas are associated with the reduced risk of food contamination, the introduction of pathogenic microbes and pest infestations (Her *et al*., 2019). Keeping food storage areas clean and well maintained, preserves the quality and safety of food, hence food waste prevention. The panel of experts indicated that insect and pest control in storage areas is crucial in food waste prevention. This finding is consistent with that of De Moraes *et al*. (2020), who illustrated that having strategies to control pests and insects in the food storage facilities is important in food waste reduction, as contamination and damage by pests and insects is limited. It was further agreed that separating chemicals and cleaning agents from food is important to prevent contamination and food waste (Faour-Klingbeil *et al*., 2020).

There was the strongest agreement on the importance of regularly checking the temperature of refrigerators in food waste prevention. As discussed in Chapter 6, Section 6.5.8.3, good temperature control preserves the quality and safety of food, since it inhibits the growth of microorganisms and prevents spoilage (Taha *et al*., 2020). In agreement with this, Van Holsteijn and Kemna (2018) indicated that maintaining optimal refrigerator temperatures can increase the 'shelf life' of food by a factor of two to three and thus the chance of food spoilage can be significantly reduced. In addition, checking and maintaining an optimal relative humidity of refrigerators is a useful strategy to reduce food waste. Optimised humidity in a refrigerator serves its purpose of food preservation rather than experiencing quality loss and spoilage, which can reduce food waste (Lipińska *et al*., 2019).

Panellists further agreed that the proper organisation of food items in the storage areas prevents food waste. In accordance with the present results, Alcorn, Vega, Irvin and Paez (2020) demonstrated that organising dry and cold storage areas, such that food is easily accessible, and spoilage and cross contamination avoided, is a critical step in reducing food waste during storage. It was agreed that the rotation of food products using the FIFO method, is imperative in maintaining food quality, hence food waste prevention. The comparison of the findings with those of other studies (Charlebois et al., 2015; Creedon et al., 2010; Derqui et al., 2016), confirmed that the FIFO approach prevents food waste as it ensures that the old stock is used before new products thus minimising waste that could occur due to the expiry of food products. In relation to this, regular checking the expiry dates of food items were viewed as a critical measure in food waste prevention. This study supports evidence from previous observations (Betz *et al*., 2015; Filimonau *et al*., 2020), which demonstrated that regularly checking expiry dates of food products and using those nearing expiry, contributed to food waste prevention. Panellists further agreed that separating raw food from cooked or ready-to-eat food, contributes to food waste prevention. In support of this, Okumus (2020) showed that separating raw food from cooked food prevents cross contamination or bacterial transfer, hence preventing food wastage due to compromised food safety. It was also agreed that keeping food covered during storage was important in food waste prevention. As discussed in

Section 6.5.8.3, covering food preserves the quality of food and avoids contamination. Another strategy that was viewed as important in preventing food waste is keeping a continuous track of food held in storage. As previously discussed, (Section 6.5.8.3) this helps in planning food production around available food items and stock forecasting, hence avoiding overstocking (Charlebois *et al*., 2015).

⇒ *Issuing*

As indicated in Table 7.14, panellists reached consensus on three (3) of the five (5) indicators (60%) in the first run of the Delphi. Consensus was not reached on two (2) of the five (5) indicators in the first run of the Delphi. One (1) additional indicator was suggested by panellists. A total of three (3) indicators were thus included in the second run of the Delphi.

TABLE 7.14: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF ISSUING ON PREVENTION OF FOOD WASTE

Indicators of issuing	Consensus (% agreement)	Standard deviation	Interquartile range
A requisition form is used to issue food from storage to production.	**62.5**	**1.126**	**2**
Only the quantity of food needed as specified on an authorised production record is removed from the storage.	87.5	0.707	1
Requested items are measured using appropriate measuring equipment before issuance.	**75**	0.835	**1.75**
Food items issued are checked against standardised recipes before production.	87.5	0.744	1
Unused food is returned to appropriate storage area.	87.5	0.991	1
Effective production planning enables issuance of the correct ingredients at the right quantities.	××	××	××

××Additional indicator suggested by panellists.

It was agreed that issuing only the amount of food needed as specified on an authorised production record was important in food waste prevention. In agreement with this, a recent study by Filimonau *et al*. (2020) reported that the issuing of the authorised amounts according to the standardised recipes, helps in avoiding excess ingredients in food preparation. One finding that was not anticipated was that the measurement of ingredients before issuing was considered unimportant in food waste prevention. This is unexpected given the importance of accurate weighing and the measurement of ingredients for good stock control and in quality food production. According to the literature (Filimonau *et al*., 2020), measuring the requested ingredients is important, as this ensures accurate quantities are issued thus avoiding food wastage that may occur if excess ingredients, other than what was required, are issued. The structuring of the statements (item limitation) might have contributed to the rejection of these indicators as they might have been vague to the panellists.

The panellists considered checking if the ingredients issued corresponded to the standardised recipes, as important in food waste prevention. As discussed in Chapter 6, Section 6.5.8.4, this factor possibly avoided food surplus and the production of poor quality products, due to the use of ingredients or quantities not specified in the recipes. As indicated in the qualitative phase of the study, inaccurate measurements of ingredients that were issued to the production unit resulted in food surplus. Panellists further agreed that returning unused or excess ingredients to the appropriate storage areas was important to reduce food wastage. A possible inference from this finding is that untouched, safe and good quality ingredients that were not used can be salvaged through returing these to storage. This may require good food handling practices and ensuring temperature and time controls so as to safeguard the quality and safety of the ingredients. This strategy may however, not apply for perishable and defrosted ingredients. These indicators have not been discussed in the current literature.

⇒ *Food production*

The results (Table 7.15 – next page) indicate that the panellists reached consensus on all eleven indicators (100%) of food production, in the first run of the Delphi.

The panellists agreed that the use of a production schedule was an important factor in preventing food waste. As discussed in Chapter 6, Section 6.5.8.5, a production schedule served as an important communication tool (linking processes) to all food service workers within the food service system. It may be viewed as important in coordinating tasks within the food service system. With a food production schedule, the entire food service team know ahead of time what will be produced, the quantites needed and the responsible personnel. This ensured that the staffing is adequate, ingredients are available in the needed quantities, pre-preparation tasks are done, food items are thawed properly, as all these functions possibly impact the safety, quality and quantity of food produced and thus have implications on food waste. It was further agreed that by measuring ingredients accurately with the appropriate equipment contributed to food waste prevention. As previously discussed (Section 6.5.8.5), accurate measurering of ingredients is an important quality and quantity control process. In this way it prevents overproduction of meals and ensures good quality production thus curbing food wastage. Proper thawing of frozen food products was considered important in food waste prevention. Comparison of the findings with those of other studies (Priefer *et al*., 2016; Vibetti, 2012) confirmed that proper thawing keeps food safe for consumption and reduces chances of food spoilage, as well as preventing quality loss and food waste.

TABLE 7.15: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF FOOD PRODUCTION ON PREVENTING FOOD WASTE

Indicators of food production	Consensus (% agreement)	Standard deviation	Interquartile range
Use of production schedules.	87.5	0.707	1
Ingredients are accurately measured with appropriate measuring equipment.	87.5	0.707	1
Food items requiring thawing are properly thawed.	87.5	0.744	1
Food is not exposed to the temperature danger zone for more than 4 hours.	100	0.518	1
Cooking temperature is properly controlled during production.	100	0.535	1
Food is cooked to appropriate cooking time.	100	0.518	1
Standardised recipes are adhered to during production.	100	0.535	1
Food is cooked to appropriate, stipulated quality standards.	100	0.518	1
Food is cooked to appropriate internal temperature.	100	0.518	1
An appropriate procedure is followed for chilling and freezing food.	100	0.518	1
Food is evaluated for quality prior to meal service.	100	0.535	1

The panel of experts indicated that by avoiding the exposure of food to the temperature danger zone prevented food spoilage and microbial growth, and preserved the quality of food, which contributed to food waste prevention (Betz *et al*., 2015; Creedon *et al*., 2010). Adhering to proper temperature control during cooking was also viewed as an important factor in food waste prevention. In agreement with this, Okumus *et al*. (2020) demonstrated that cooking food to the right temperature maximised the quality of food and reduced food waste. Additionally, panellists agreed that cooking food for the correct time was important in food waste reduction. According to Al-Kandari *et al.* (2019), time control is important in preventing microbial growth and retaining the quality of food, hence food waste prevention. The findings further indicate the importance of adherence to standardised recipes. In accordance with the present results, previous studies (Goonan *et al*., 2014) have demonstrated that adhering to standardised recipes reduces the amount of food waste as it helps in the accurate forecasting of meal quantities, promotes quality food production and helps in attaining precise yields thus avoiding overproduction. Similarly, cooking food to the set standards of quality was viewed by panellists as an important factor in food waste prevention. A possible explanation is that cooking food to the expected quality standards minimises the chances of discarding food due to poor quality and increases customer food acceptance and satisfaction.

Panellists agreed that cooking food to the appropriate internal food temperatures was important in food waste prevention. As discussed in Section 6.5.8.5, this has implications on food quality and safety, hence food waste prevention. The literature (Mervier *et al*., 2017) shows that maintaining the acceptable internal food temperature, slows the growth of micro-organisms, conserves the safety and quality of food, which minimises the chances of food disposal. The panel of experts agreed that following an appropriate procedure for chilling and freezing food under the cook-chill and cook-freeze systems was important in food waste prevention. A possible explanation for this is that appropriate implementation of these systems preserves the quality and safety of food. The evaluation of the quality of meals before service was scored as important in food waste prevention. This factor was discussed in Section 6.5.8.5 as being important; where the acceptable level of quality was not reached, errors were rectified during production, reducing the likelihood of service-waste as a result of meals being rejected by the customers.

⇒ *Distribution*

According to the findings, all nine (9) indicators (100%) under food distribution reached consensus in the first run of the Delphi (Table 7.16 – next page). Two (2) additional indicators were suggested as important in preventing food waste. These were included in the second run of the Delphi.

The panellists further agreed that monitoring food holding temperatures was an important strategy contributing to food waste prevention. As discussed in Section 6.5.8.6, the literature supports that monitoring and maintaining the appropriate cold- or hot-holding temperature is essential for controlling the growth of pathogenic microbes and ensuring safety, which in turn minimises the chances of food disposal. Following an appropriate procedure when reheating food, was also viewed as a critical measure in food waste prevention. In the same way, this preserved not only the safety but also retained the quality of food. It was further agreed that reheating food in small batches reduced food waste. As previously discussed (Section 6.5.8.6), reheating in small batches minimised the chances of discarding excess food that may be leftover after service, as food safety plans prohibit the re-use of reheated leftover food.

TABLE 7.16: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF DISTRIBUTION ON PREVENTING FOOD WASTE

Indicators of distribution	Consensus (% agreement)	Standard deviation	Interquartile range
Specialised equipment with approved temperature controls is used.	100	0.518	1
Food holding temperatures are monitored.	100	0.463	0.75
An appropriate procedure is followed for reheating food.	100	0.535	1
Reheating is done in small batches.	87.5	0.707	1
Frozen food is reheated to appropriate service temperature.	100	0.535	1
Sensory quality is retained during reheating.	100	0.535	1
Proper equipment is used for distribution.	87.5	0.756	1
Temperature of food is properly controlled.	100	0.463	0.75
Time at which food is held under distribution is controlled.	100	0.518	1
Minimise holding time between production / reheating and serving.	××	××	××
Proper packaging of food distributed.	××	××	××

××Additional indicator suggested by panellists.

The panellists agreed that reheating frozen meals to the appropriate service or internal temperature was important in food waste prevention. Similarly, this ensured that the food was possibly safe for consumption and thus reduced the chances of being discarded, due to food safety risks. Proper rethermalisation procedures that retained the sensory quality of food was viewed as important in food waste prevention. A possible explanation for this is that, retaining the sensory quality of food may increase the chances of acceptability of food by consumers, hence minimising service waste and plate waste.

The findings further indicate that panellists agreed that using the proper equipment for distribution is a contributing factor to food waste prevention. Depending on the complexity of the meal distribution system, this equipment may range from hot- and cold-holding equipment to electrically heated or cooled carts or trucks used for transportation (Greigore, 2017:203). The availability and usage of proper distribution equipment may help in maintaining the correct temperatures between production and service, hence curbing food waste due to quality and food safety issues. This illustrates the importance of distribution equipment as inputs in the distribution functional subsystem. Proper temperature control is shown to be very important in this process, and ultimately in food waste reduction. As discussed in Section 6.5.8.6, proper temperature control preserved the safety of food served to customers. The panellists also demonstrated that time control during distribution was critical in food waste reduction. Minimising the distribution time has important implications on temperature maintenance, avoiding exposure of food to the temperature zone, and maintaining the safety and quality of food. Keeping the amount of time between the completion of production until the time of service, or limiting the distribution time, may thus positively impact on food waste reduction.

⇒ *Service*

According to the findings, consensus was reached with nine (9) of the eleven (81.8%) indicators in the first run of the Delphi (Table 7.17). For two (2) of the eleven indicators (18.2%), consensus failed and these two (2) were included in the second run of the Delphi.

Evaluating the quality of meals at the point of service before serving customers was regarded as an important factor in preventing food waste. As discussed in Chapter 6, Section 6.5.8.7, inspecting food quality prior to service, allows food service operators to rectify quality errors to minimise chances of rejection of the food by the customers. Notwithstanding this, a proactive and preventative quality assurance approach needs to be embedded in the processes of the food service system rather than a reactive approach as some quality errors may not be rectified at the service point, hence food waste generation.

TABLE 7.17: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF SERVICE IN PREVENTING FOOD WASTE

Indicators of service	Consensus (% agreement)	Standard deviation	Interquartile range
Front-of-house staff check quality of food before service.	87.5	0.707	1
Portions of food are verified upon receipt from back-of-house.	100	0.518	1
Bain-marie counter, chaffing dishes and heated cabinets are kept at correct temperatures.	100	0.518	1
Internal food temperature is measured and recorded.	87.5	0.744	0
An appropriate food temperature is maintained during service.	100	0.535	1
Food is kept covered until service.	100	0.518	0
Standardised serving utensils are used for portioning.	**75**	0.886	**1.75**
Portioning is done correctly.	87.5	0.756	1
Food is neatly plated and presented.	**75**	0.756	**1.5**
Proper management of surplus food.	100	0.518	1
The amount of time food is held under temperature danger zone is highly controlled.	100	0.463	0.75

The verification of the food portion count received from the back-of-house was scored as an important food waste prevention measure. As previously discussed (Section 6.5.8.7), it was perceived that portion control measures were important to ensure the accuracy in portioning, hence minimising food loss due to poor portion control. Maintaining the correct temperature of the holding equipment at the service point was viewed as important in food waste prevention. Similarly, maintaining appropriate food temperatures during service was highlighted as an important food waste prevention measure. Panellists further agreed that measuring and recording the internal temperature of food, as well as reducing the time that food is held under or above the temperature danger zone were important strategies contributing to food waste prevention. It can thus be inferred that temperature control and maintenance is a critical component of food waste control. In agreement with this, Mercier *et al*. (2017) indicated that food temperatures, food safety and food waste are linked; failing to maintain the acceptable food temperatures can stimulate the growth of pathogens and spoilage microbes and render the food product inedible.

It was agreed that keeping food covered during service was important in food waste prevention. A possible explanation for this finding, is that to keep food covered preserved the safety and aesthetic quality of food. As previously discussed (Section 6.5.8.7), covering food retains the texture and colour, prevents moisture loss, protects food from contaminants and possibly helps in temperature maintenance. Panellists further agreed that correct portioning contributed to the reduction of food waste. This is in agreement with the studies of Goonan *et al*. (2014), Kasavan *et al*. (2019) and Pinto *et al*. (2018), who indicated that correct portioning may reduce food waste caused by oversized portions. The findings further revealed agreement on the importance of proper management of surplus food. This is in agreement with the findings of the study conducted by Betz *et al*. (2015), who indicated that where leftover foods are properly managed by chilling or freezing within the controlled times, the growth and multiplication of microbes is avoided thus preventing food spoilage and reducing food wastage. There was a strong agreement on the importance of a tight control of the amount of time food is held under or above the temperature danger zone at the service point. This is essential in controlling the growth of pathogenic microbes (Ross *et al*., 2006).

The next section presents and discusses findings on the level of agreement on the importance of sustainability practices in the first round of the Delphi.

7.5.1.3 Sustainability practices preventing food waste

This section discusses the level of agreement of the importance of sustainability practices in preventing food waste. Sustainable practices are discussed under two categories, namely environmentally focused sustainable practices, and sustainable food practices. The indicators that reached agreement in the first run of the Delphi are discussed. Those which failed to reach consensus and the additional indicators, which were suggested by the panellists, were included in the second run of the Delphi and are discussed under round 2.

- *Environmentally focused sustainable practices*

The findings indicate a lack of consensus on the importance of all the six (6) indicators of environmentally focused practices in preventing food waste (Table 7.18). Four (4) additional indicators were suggested by the expert panel as important in food waste prevention. It was further suggested that the indicator on limiting the use of water be eliminated as it was covered under the reduction of the amount of water used during production. A total of nine (9) indicators were thus included in the second round of the Delphi survey. These will be discussed under round 2.

TABLE 7.18: LEVEL OF CONSENSUS ON THE IMPORTANCE OF ENVIRONMENTALLY FOCUSED SUSTAINABLE PRACTICES IN PREVENTING FOOD WASTE

Indicators of environmentally focused sustainable practices	Consensus (% agreement)	Standard deviation	Interquartile range
Less energy-consumption cooking methods are adopted.	**75**	0.916	1
Adherence to optimal cooking times.	**75**	0.535	1
Batch cooking	**37.5**	0.744	1
Reduced food miles (distance food travels from the supplier to food service unit is reduced).	100	**1.195**	**2**
Limiting use of running water, for example, do not thaw food under running water.	87.5	**1.126**	**1.75**
Reduction of the amount of water used during production.	**62.5**	**1.126**	**1.75**
Conservation of energy when cooking.	××	××	××
Kitchen with good ventilation.	××	××	××
Keeping cool air in refrigerator from going out and reduction of opening frequency.	××	××	××
Regular cleaning and maintenance of kitchen appliances.	××	××	××

××Additional indicator suggested by panellists.

The next section presents the results on the level of consensus on the importance of sustainable food practices in preventing food waste.

- *Sustainable food practices*

As shown in Table 7.19, only two (2) of the five 5 (40%) sustainable food practices reached consensus in the first round of the Delphi survey, with a level of agreement of over 80% of the experts, a standard deviation of <1, and an interquartile range of ≤1. Consensus failed to be reached for three (3) of the five (5) (60%) indicators and four (4) indicators were suggested and added in the first round of the Delphi survey. A total of seven (7) indicators were included in the second round of the Delphi survey and these are discussed under round 2.

The panel of experts agreed on the importance of cooking-to-order in food waste prevention. This also concurs with our earlier observations (qualitative phase), which showed that cooking-on-demand reduced food waste that may occur due to overproduction, as only the quantities ordered were prepared. These results reflect those of Michalec, Fodor, Hayes and Longhurst (2018) and Gładysz, Buczacki and Haskins (2020), who also found that cooking-to-order generated less food waste. Panellists also agreed that employing creative ways to use leftovers is an important factor contributing to food waste prevention. In this way, left over menu items are used in other recipes to create new dishes thus recouping food that would be discarded. In accordance with the present results, previous studies (Quested *et al*., 2013) demonstrated that the use of leftovers to make new menu items, reduced food waste.

TABLE 7.19: LEVEL OF CONSENSUS ON THE IMPORTANCE OF SUSTAINABLE FOOD PRACTICES IN PREVENTING FOOD WASTE

Indicators of sustainable food practices	Consensus (% agreement)	Standard deviation	Interquartile range
Use of locally sourced ingredients.	**50**	**1.165**	**2**
Purchase and utilisation of seasonal food.	**75**	**1.126**	**1.75**
Cook to order.	87.5	0.744	0.75
Employ creative practices of utilising leftovers.	100	0.535	1
Use garnishes to a limited extent.	**50**	**1.488**	**2**
Purchase and utilisation of organic food.	××	××	××
Make changes to the menu to adapt to available products.	××	××	××
Traceable food supply chain.	××	××	××
Follow the food safety and sanitation regulations.	××	××	××

××Additional indicator suggested by panellists.

7.5.1.4 Summary of Delphi round 1

The results indicate that consensus was reached on eight (8) dimensions of total quality management practices, and 87 indicators at the end of the first round of the Delphi. Twenty nine (29) indicators failed to reach consensus. A total of 20 indicators were suggested by the panellists and were added to the second run of the Delphi. Under sustainability practices, one (1) of the two (2) dimensions reached consensus, namely food focused sustainable practices, and only two (2) indicators reached consensus while a total of nine (9) indicators failed to do so. One (1) indicator was removed as it duplicated another. A total of eight (8) indicators of sustainability practices were suggested and added after the first run of the Delphi. This is illustrated in Table 7.20.

TABLE 7.20: SUMMARY OF DELPHI ROUND 1 RESULTS

Components	Dimensions	*n* (total indicators in Delphi survey 1)	*n* (reached consensus)	*n* (failed consensus)	*n* (added indicators)
TQM Practices	Quality practices of top management	10	6	4	1
	Customer focus	5	2	3	2
	Employee management and involvement	9	5	4	3
	Process quality management	8	6	2	2
	Employee knowledge and education	6	2	4	2
	Supplier quality management	9	7	2	2
	Information and analysis	4	1	3	4
	Process and product quality design				
	Purchasing	6	5	1	1
	Receiving	9	8	1	0
	Storage and inventory control	14	13	1	0
	Issuing	5	3	2	1
	Production	11	11	0	0
	Distribution	9	9	0	2
	Service	11	9	2	0
	TOTAL NUMBER OF TQM INDICATORS	**116**	**87**	**29**	**20**
Sustainability practices	Environment focused practices	6	0	6(-1*) = 5	4
	Food focused practices	5	2	3	4
	TOTAL NUMBER OF SUSTAINABILITY INDICATORS	**11**	**2**	**8**	**8**

*1 indicator was removed as it was similar to another.

The indicators that failed to reach consensus, as well as additional ones suggested, will be discussed under Round 2.

The next section discusses the findings on the level of consensus of the importance of total quality management practices and sustainability practices in food waste prevention, from the second run of the Delphi.

7.5.2 Delphi round 2

In round 2, the level of agreement was used to measure the consensus of the indicators (Bentley *et al*., 2016). Indicators with a level of agreement of ≥ 80%, were considered to have reached consensus that they were important in reducing food waste. As elaborated in Chapter 4, Section 4.17, and as highlighted in Section 7.4, the standard deviation and interquartile range were not applied to analyse data in this second run, as the sample was too small; only the level of percentage agreement was used to assess consensus. The small sample size increased the margin of error and decreased the statistical power in the application of standard deviation and interquartile range, hence using the percentage level of agreement only. The following section presents the response rate, the indicators which reached consensus, and those that failed in the second round of the Delphi process.

7.5.2.1 Response rate in Delphi round 2

Of the nine (9) panellists who completed the first run of the Delphi survey, (six) 6 completed the second run of the Delphi survey. The response rate for round 2 was therefore, 66.7% (n=6).

7.5.2.2 Total quality management (TQM) practices preventing food waste

This section discusses, from the second round of the Delphi survey, the level of consensus of the importance of total quality management practices.

Quality practices of top management

A total of five (5) indicators; four (4) of which did not reach consensus in round 1, and an additional one (1) added by the panellists in round 1, were included in the second run of the Delphi; all of these reached consensus that these were important in preventing food waste (level of agreement ≥ 80%) (Table 7.21).

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

TABLE 7.21: LEVEL OF CONSENSUS ON THE IMPORTANCE OF QUALITY PRACTICES OF TOP MANAGEMENT IN PREVENTING FOOD WASTE (ROUND 2)

Quality practices of top management	Consensus(% agreement)
Food quality policy is taken into consideration in strategic planning.	100
Food quality policy is communicated throughout the food service unit.	83.3
Management gives employees authority to manage food quality problems.	83.3
Management sets food quality strategies for employees.	83.3
Management liaise with personnel to get their input regarding quality policies and their implementation.	83.3

In the second round of the Delphi survey (% agreement = 100), it was agreed that taking the food quality policy into consideration in strategic planning was important. This indicator may contribute to preventing food waste, as taking the food quality policy into account when planning, may mean committing resources and developing standards for monitoring and evaluating quality performance, which may allow the food service operation to take appropriate corrective actions (Gregoire, 2017:269). In this way, the quality of menu items will be ensured, hence cutting down on food waste that may occur due to quality failures. It was agreed that communicating the food quality policy throughout the food service unit, can curb food waste. In support of this, Goonan *et al*. (2014) illustrated that this improves the understanding of adherence and commitment to the implementation of food policies, hence the production of quality meals, which reduces the generation of food waste.

The panellists agreed that giving the employees authority to manage food quality problems (**management function**) contributed to preventing food waste. This result is in agreement with the literature (Ugboro & Obeng, 2000), which indicates that delegating authority to employees to manage quality problems; authority to resolve customers' quality-related problems, authority to accept or reject quality of one's own work, or the work of others, and the authority to make quality-related decisions, led to job satisfaction, customer satisfaction and quality improvement. In this way food waste may be prevented. Additionally, giving employees the authority to manage quality problems is expected to counteract food production errors before they occur, hence prevention of food waste. It was agreed that setting food quality strategies for employees was important in preventing food waste. The planning aspect of the management function of food service organisations involves the formulation of quality strategies, goals and objectives, policies, plans and control systems that facilitate the achievement of quality food products. These may serve as guides for employees and help align their activities and decisions with attainment of quality food production and service, hence reducing food waste. It was further agreed that the liaison of management with personnel to obtain their input regarding quality policies and their implementation was important in preventing food waste. The literature (Welikala & Sohal, 2008) indicates that the sustainability and successful implementation of quality strategies is dependent on employee involvement. It may be concluded that for food quality strategies to be successfully implemented and to reduce waste, input has to be sought from food service workers.

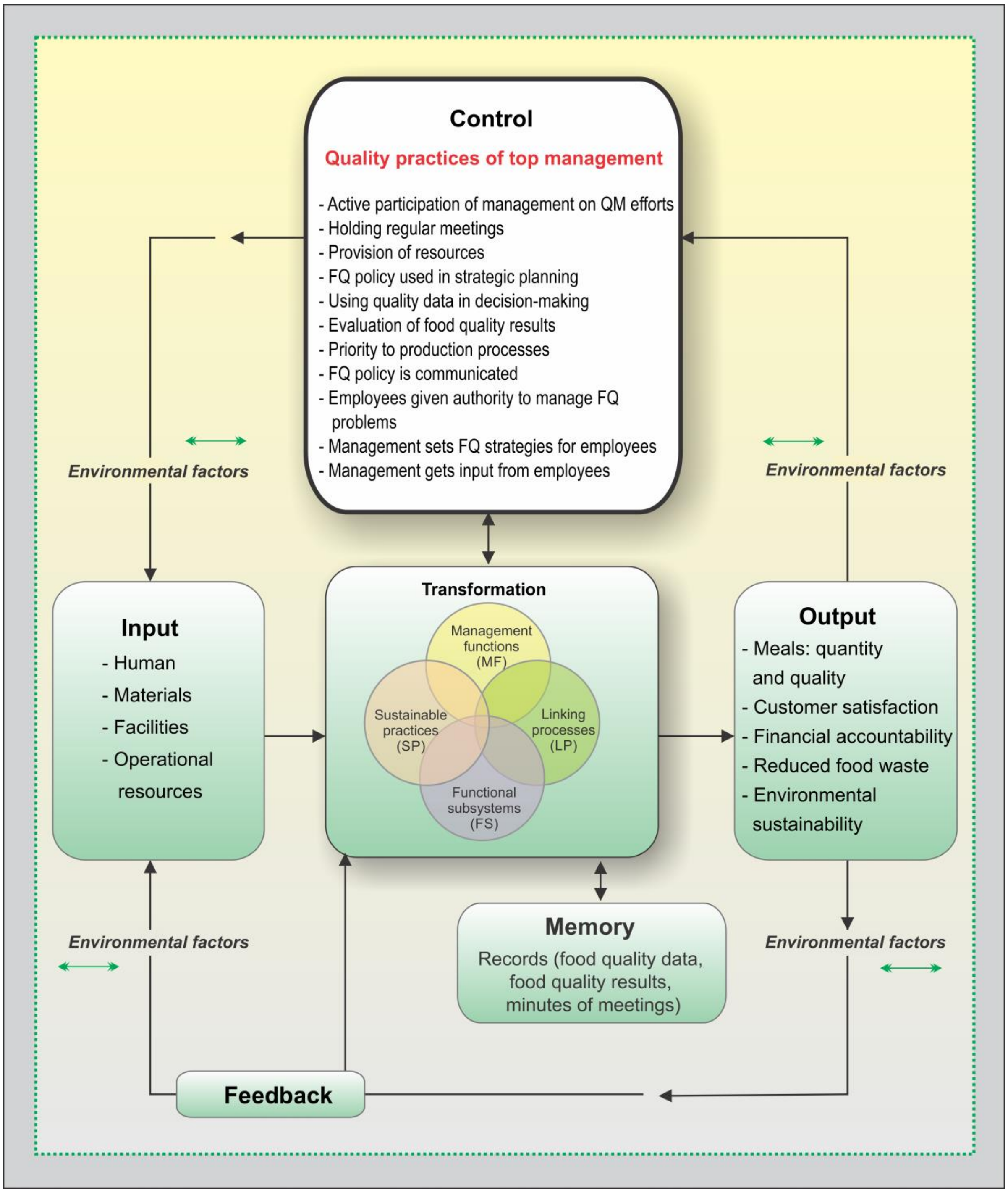


FIGURE 7.1: QUALITY PRACTICES OF TOP MANAGEMENT IN PREVENTING FOOD WASTE

In summary, at the end of the two runs of the Delphi survey, all **eleven (11) indicators** of quality practices of top management were validated as important in reducing food waste (Figure 7.1).

- *Customer focus*

Five (5) indicators of customer focus were included in the second run of the Delphi (Table 7.22). Only one (1) indicator reached consensus in the second round of the Delphi and four (4) were rejected.

TABLE 7.22: LEVEL OF CONSENSUS ON THE IMPORTANCE OF CUSTOMER FOCUS IN PREVENTING FOOD WASTE (ROUND 2)

Customer focus	Consensus (% agreement)
Customers are encouraged to submit complaints and proposals for quality improvement.	**66.7**
Customer suggestions are taken into consideration for quality improvement.	**66.7**
Customers' suggestions are recorded and analysed.	83.3
There is open communication with customers.	**50**
Management of customer expectations.	**67.7**

This study did not find the importance of encouraging customers to submit complaints and proposals for quality improvement, prevented food waste. This is contrary to what was thought, that, encouraging customers to give feedback and suggestions of improvements may widen an understanding of customers' expectations. An understanding of customer expectations may enable the food service operation to address quality gaps, hence the acceptance of meals by customers, and the reduction of service and plate waste. Another indicator being customer suggestions are taken into consideration for quality improvement, also failed to reach consensus. This differs with past literature (Heikkilä *et al.*, 2016), which indicates that the consideration of customer suggestions can help the food service operation respond to the needs and complaints of customers, which may lead to the improvement of food quality, increase customer satisfaction, and as a result, reduce the amount of waste generated.

The results further indicated that in the first round of the Delphi, panellists did not reach consensus on the importance of recording and analysing customer suggestions. However, consensus was reached on this indicator in the second round. As discussed in Chapter 6, Section 6.5.2, recording and analysing customer feedback helps food service operations to better understand the customer requirements and identify areas that need improvement. This finding broadly supports the work of Heikkilä *et al*. (2016), who demonstrated that the analysis of customer feedback allows the food service operation to react to complaints; this may lead to the improvement of quality, hence the acceptance of meals by customers and food waste reduction. Panellists suggested the addition of two (2) indicators, namely 'there is open communication with customers' and 'management of customer expectations'. These were included in the second round of the Delphi and both failed to reach consensus. It was not anticipated that there would be disagreement on the importance of open communication with customers. Contrary to the findings, research (Heikkilä *et al*., 2016) demonstrates that open communication with customers, for example, about the nutritional value of meals provided, portion sizes and customer needs and expectations, is an important element that enables food service operations to understand customers. This is important as it helps in adequately addressing the needs of customers, thus reducing service and plate waste. The construct on the management of customer expectations failed to reach consensus. This is contrary to previous literature (Heikkilä *et al*., 2016), which illustrated that the failure to address customers' expectations and hopes for the food, contributes to food waste.

In summary, the study validated **three (3) indicators** of customer focus as important in food waste reduction (Figure 7.2), and a total of **four (4) indicators** were viewed as unimportant, in the context of the University food service units.

- *Employee management and involvement*

Four (4) indicators did not reach consensus in the first round of the Delphi and three (3) additional indicators were suggested as important in preventing food waste. These were included in the second run of the Delphi, where five (5) indicators reached consensus, while two (2) failed to do so (Table 7.23).

TABLE 7.23: LEVEL OF CONSENSUS ON THE IMPORTANCE OF EMPLOYEE MANAGEMENT AND INVOLVEMENT IN PREVENTING FOOD WASTE (ROUND 2)

Employee management and involvement	Consensus (% agreement)
Employees who improve food quality are rewarded.	**66.7**
Employees are evaluated on how well they ensure food quality.	83.3
Systems exist for promoting teamwork across the food service system.	83.3
Approaches to work promote open communication between departments and food service units.	83.3
Change management of personal attitudes of employees towards quality management and waste.	83.3
Employees are provided with feedback on performance to encourage continuous improvement.	83.3
Job description in terms of food quality is clear.	**67.7**

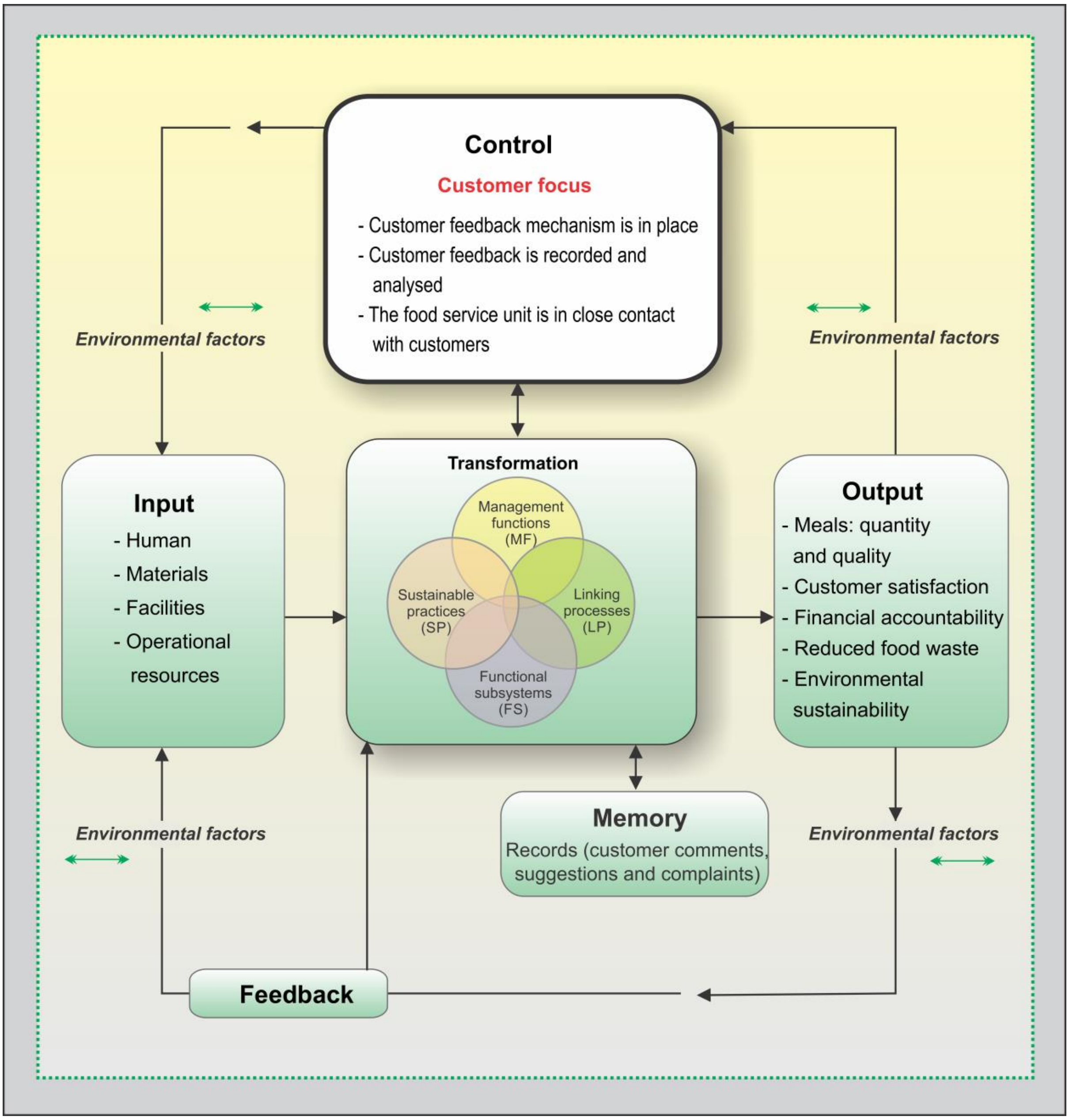


FIGURE 7.2: INDICATORS OF CUSTOMER FOCUS CONTRIBUTING TO FOOD WASTE PREVENTION

There was lack of consensus on the importance of rewarding employees who improve food quality, in preventing food waste. This finding is contrary to previous studies and the assumptions of the expectancy theory, which suggested that rewarding employees (extrinsic and intrinsic rewards) improved quality performance (Chiang & Jang, 2008). Contrary to the findings, it may be expected that rewards, such as money, promotion, time-off, a sense of fulfilment or achievement, may motivate employees to improve quality performance, which may contribute to food waste prevention. The results indicated agreement on the importance of 'evaluating employees on how well they ensure food quality' on food waste prevention. Empirical research (Chiang & Jang, 2008; Soltani & Wilkinson, 2020) suggests that employee-evaluation using such systems as performance appraisal, is effective in improving the quality, changing employee work behaviour and enhancing employee job satisfaction and performance. It can thus be expected that these changes may positively contribute towards food waste reduction in food service operations.

The results indicated consensus on the importance of the availability of systems to promote teamwork across the food service system, to prevent food waste. This may be expected, given the **interdependency** nature of the food service system. Further to that, approaches to quality, such as the Kaizen philosophy, place emphasis on interdepartmental teamwork for successful implementation of quality improvement strategies (Marin-Garcia, Juarez-Tarraga & Santandreu-Mascarell, 2018). In agreement with the findings, the literature shows that teamwork among food service workers, within and across different units or departments of the food service system, is important in food waste prevention (Goonan *et al*., 2014; Ofei *et al*., 2014). Where there is teamwork, employees may be expected to work collectively to ensure good quality production across the system, communicate issues that may affect food quality and waste generation, and understand that they have a collective responsibility towards food waste prevention. The indicator 'approaches to work promote open communication between departments and food service units' reached consensus. This demonstrates the importance of communication as a part of the **linking processes** in the food service system. In support of this, Charlebois *et al*. (2015) and Heikkilä *et al*. (2016) found that enhancing and promoting communication is important in food waste prevention. For instance, communication about stock levels, and the use of food products that are about to expire, may lead to menu changes, hence preventing food waste. A study by Luu (2020) also indicated that effective communication positively influenced employees' intention to reduce food waste and their reduced food waste behaviour.

The panellists further identified change management of food service workers as an important factor in food waste reduction. According to the literature (Sakaguchi, Pak & Potts, 2018), tackling food waste requires a change in employee behaviour and attitude. Goonan *et al*. (2015) applied the social practice theory and showed that food waste prevention required a change of behaviour of food service workers, which meant transformation of current practices to more pro-environmental patterns of consumption. The expert panel reached consensus on the importance of feedback on the provision on food waste prevention. Feedback provision is in itself paradoxical in nature, as it can be either commitment-focused or control-focused. According to Van Assen (2018:11), 'commitment-focused attributions imply positive consequences for employees', while 'control-focused attributions suggest negative consequences'. In line with this, Kumar, Kumar, De Grosbois and Choisne (2009) indicated that proper performance measurement and providing feedback leads to employee motivation, direction for improvement and corrective action. It can therefore, be argued that the extent to which provision of feedback may contribute to quality improvement and food waste management, depends on how the employees perceive the performance measurement and feedback provision exercise. Contrary to expectations, there was a lack of agreement on the importance of a clear job description on food waste prevention. This rather contradictory result may be due to errors in the interpretation of this indicator, as a contributing factor to quality performance and waste reduction. Given that a clear job description is an important part of human resource planning, it can be expected that it positively impacts on quality performance and waste reduction. The result of the study on this aspect is different to previous studies (Husin & Kler, 2014), which demonstrated the importance of a clear job description in lessening role conflict, role ambiguity and role overload thus leading to productivity and good quality performance.

Two (2) indicators failed to reach consensus and two (2) additional indicators were suggested in the first round of the Delphi survey. A total of four (4) indicators were thus included in the second run of the Delphi. Two (2) of the four (4) indicators reached consensus, and the other two (2) failed to reach consensus (Table 7.24).

TABLE 7.24: LEVEL OF CONSENSUS ON THE IMPORTANCE OF PROCESS QUALITY MANAGEMENT IN PREVENTING FOOD WASTE (ROUND 2)

Process quality management	Consensus (% agreement)
Process non-conformities are detected through internal audits.	**66.7**
Setting ranges within which non-conformities are tolerated or allowed.	**66.7**
Hazard Analysis and Critical Control Points (HACCP) system is put in place.	83.3
Good manufacturing practices (GMPs) are put in place.	83.3

Detecting process non-conformities through internal audits, and setting ranges within which non-conformities are tolerated or allowed, were viewed as unimportant in food waste prevention in the food service context (level agreement – 66.7%). Contrary to the findings, the detection of process non-conformities through internal audits, may be expected to be an important factor in food waste reduction, by ensuring that menu items meet quality standards and customers' expectations. This could prevent waste from occurring, due to quality failure and customer rejections. The literature concerning the food sevice sector (Charlebois *et al.*,

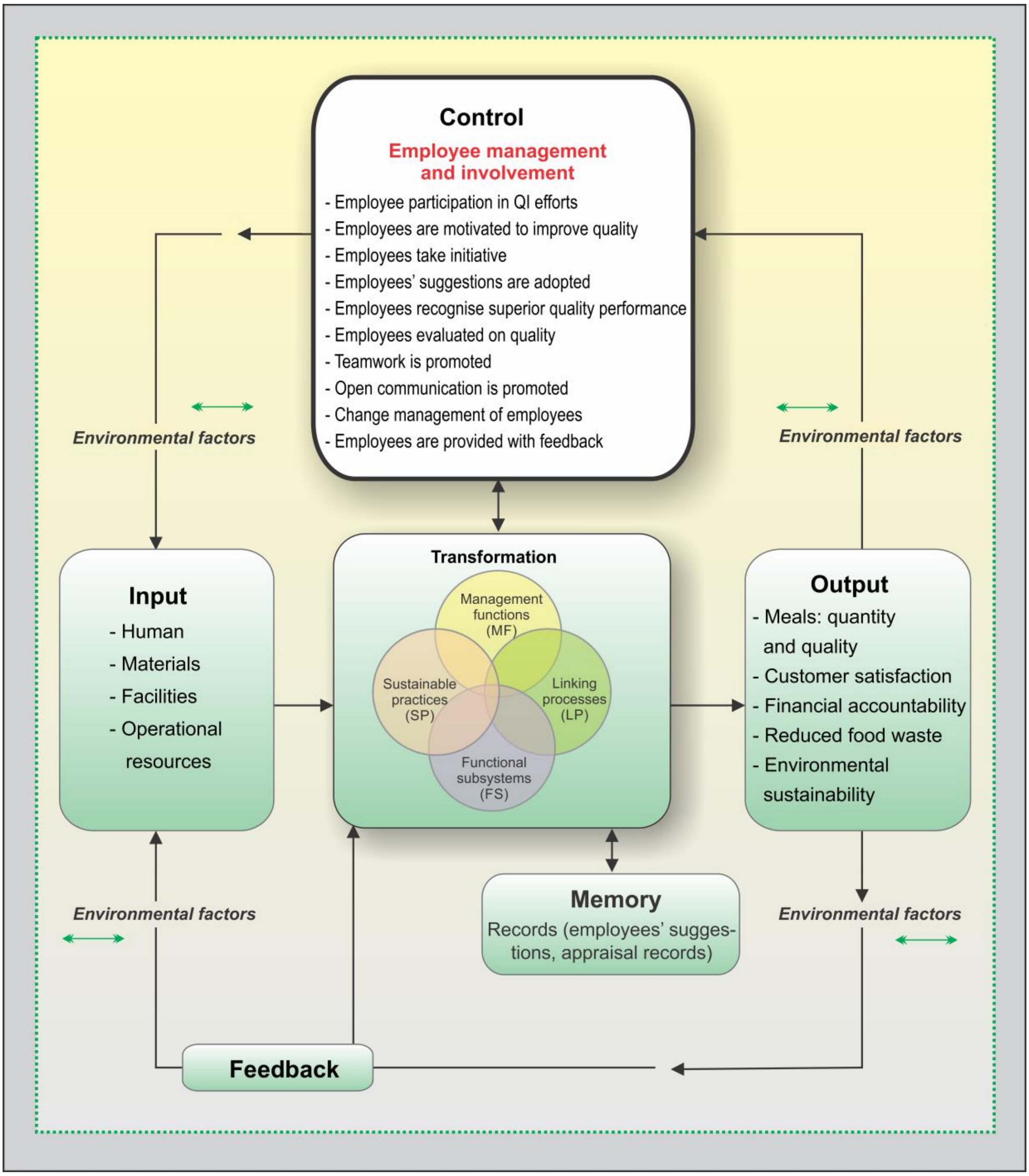


FIGURE 7.3: EMPLOYEE MANAGEMENT AND INVOLVEMENT INDICATORS IN PREVENTING FOOD WASTE

2015) similarly demonstrates that internal quality audits ensure consistency and timeliness in the delivery of meals, hence preventing food waste due to defects and customer dissatisfaction. The study did not find, by setting ranges within which non-conformities are tolerated or allowed, to be important in food waste reduction in the University food service context. According to the literature search, this area remains unresearched in the food service sector. However, it can be expected that by setting ranges, within which non-conformities are allowed, may assist in food waste prevention in that it may allow food service operations to be aware, understand and strive to meet the set quality requirements. This may be closely related to the requirements of the ISO 9000 quality audit, which requires that deviations from expectations or non-conformity be documented and reported to management, so that corrective actions may be implemented (Broughton, 2020). Corrective actions may prevent a particular instance of non-conformance from recurring, and improve quality performance, hence curtailing food waste generation.

The expert panel further added two (2) indicators, which were ‘putting in place a Hazard Analysis and Critical Control Points (HACCP) system’, as well as ‘putting in place Good Manufacturing Practices (GMPs)’. These were also added to the survey for the second round of the Delphi and they both reached consensus. Previous studies (Zagorski, Reyes, Prescott & Stasiewicz, 2020) have suggested that compliance with the HACCP system, reduces food wastage, as it means hazards and safety risks, such as foodborne pathogens and allergens, cross contamination, and hazards, due to time-temperature abuse, are identified and prevented. HACCP emphasises prevention rather than inspection (Ko, 2013). In this way, the management of food safety ensures that safe food is produced and eliminates the chances of discarding food, due to food safety failure. The implementation of GMP was also considered important in food waste prevention. GMP and HACCP systems are interrelated and interdependent; to implement HACCP, the operator should have satisfactorily implemented GMP (Inter-American Institute for Cooperation on Agriculture, 2009). Both systems ensure food safety thus salvaging food that could have otherwise been wasted, due to the failure to comply with safety requirements.

At the end of the two runs of the Delphi, **eight (8) indicators** of process quality management were validated as important in food waste prevention (Figure 7.4). A total of **two (2) indicators** were rejected and indicated as unimportant in food waste prevention in the University food service sector.

- *Employee knowledge and education*

Four (4) indicators, which did not reach consensus, and two (2) additional indicators that were suggested, were included in the second run of the Delphi. A total of six (6) indicators were thus included in the second round of the Delphi survey. Three (3) indicators reached agreement and three (3) failed to reach consensus (Table 7.25).

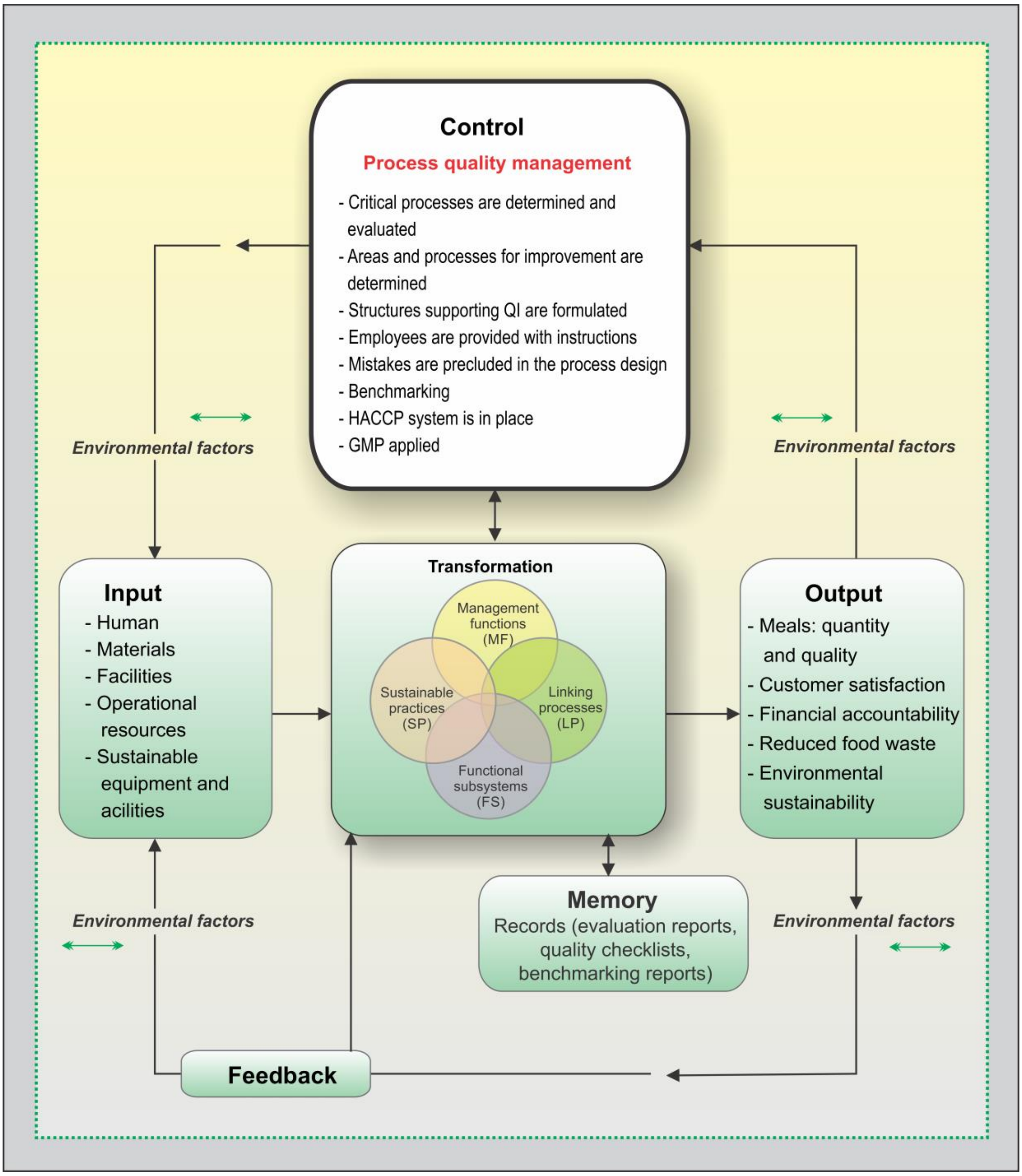


FIGURE 7.4: PROCESS QUALITY MANAGEMENT INDICATORS IN PREVENTING FOOD WASTE

According to the findings, evaluating the qualifications of employees for relevance with food service was considered unimportant in food waste prevention. Perhaps this implies that qualifications related to food service are not always a requirement or important in ensuring meticulous food production and service. The literature on the food service industry (Goonan *et al*., 2014; Heikkilä *et al*., 2016) emphasises the importance of skilled, competent and trained staff in food waste prevention. However, it may be argued that professional skills and competency in food service may be gained through in-service training and not necessarily by

TABLE 7.25: LEVEL OF CONSENSUS ON THE IMPORTANCE OF EMPLOYEE KNOWLEDGE AND EDUCATION IN PREVENTING FOOD WASTE (ROUND 2)

Employee knowledge and education	Consensus (% agreement)
Qualifications of employees are evaluated for relevance with food service	**33.3**
Employees have experience in food service	**33.3**
Employees are trained in topics with regard to their specialty and daily work in different areas of food service	**50**
Employees are offered quality orientated training	83.3
Training newly appointed staff members prior assumption of duty	83.3
Training employees in all control measures to minimise waste	83.3

obtaining formal, long-term training in the culinary field. The importance of in-service training in food waste prevention was discussed in Chapter 6, Section 6.5.5. No consensus was reached on the importance of employees' experience in food service on food waste reduction. This finding is contrary to previous studies, which have suggested that employees' experience of food production methods, mastering recipes and carrying out general food service tasks, has a profound effect on food waste prevention (Heikkilä *et al*., 2016). It may be expected that experienced food service workers make fewer food production and service mistakes than inexperienced workers, hence food waste reduction.

Panellists failed to reach consensus on the importance of training employees in areas with regard to their specialty and daily work. This is contrary to expectations. As discussed in Chapter 6, Section 6.5.5, training food service workers in areas related to their specialised roles, enhanced their skills and quality performance, hence food waste reduction. Contrary to the findings, Mosadeghrad (2014) illustrated that employee training enhances the workforce's knowledge and skills, minimises employees' errors and the need for reproduction of faulty products, hence waste reduction.

The results indicate agreement on the importance of quality-orientated training on food waste reduction. This outcome is in agreement with that of Sadikoglu and Zehir (2010) and Talib *et al*. (2013), who demonstrated that employee training to do with quality management, provides sustainability of quality management systems in an organisation and transforms workers into creative problem-solvers, who are able to take initiative and solve quality-related problems. In this way, it can be expected that problems concerning quality are tackled before errors occur, hence food waste reduction. The results demonstrate the importance of training newly appointed staff members on food waste prevention prior to their assumption of duty. The importance of staff orientation and induction on food waste prevention is not documented in the food service literature. However, staff orientation and induction can be viewed as part of training and development, which is particularly important for newly appointed staff members, as it orientates them to such aspects as organisational policies, procedures and plans, equipment-use and general orientation of the day-to-day duties of food service workers.

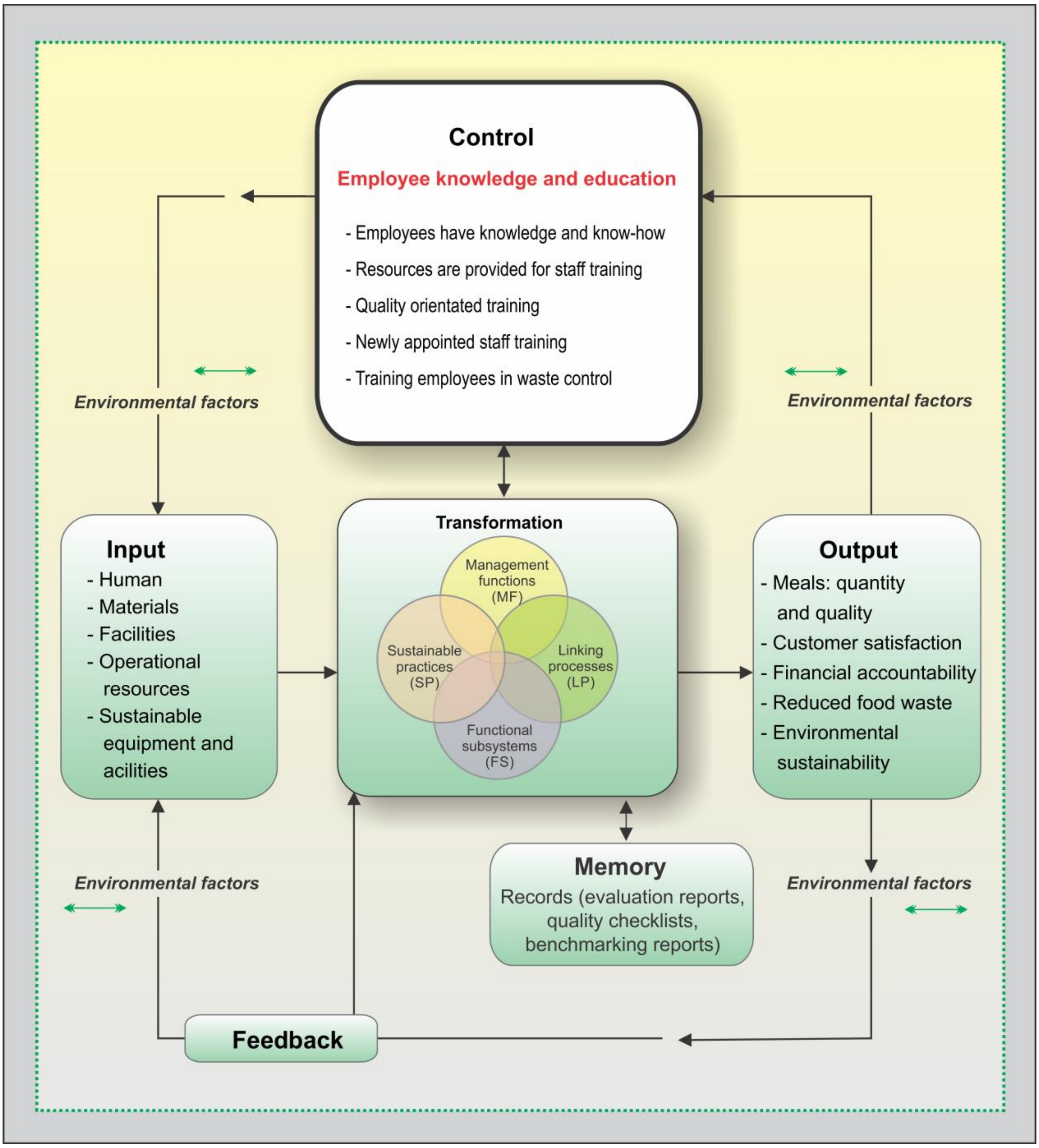


FIGURE 7.5: EMPLOYEE KNOWLEDGE AND EDUCATION INDICATORS IN PREVENTING FOOD WASTE

This may be expected to empower food service workers and enable them to seamlessly carry out their duties with minimal production errors, hence food waste minimisation. Training employees in all control measures to minimise waste was viewed as an important factor in preventing food waste. The knowledge of food waste mitigation measures is presumed to enable food service workers to implement these throughout the food service system. The literature (Mabaso, 2017) shows that training employees on food waste management is an important effort towards food waste reduction.

In summary, **five (5) indicators** of employee knowledge and education were validated as important in preventing food waste (Figure 7.5). A total of **three (3) indicators** were rejected and indicated as unimportant in food waste prevention in the University food service sector.

- *Supplier quality management*

A total of four (4) indicators were included in the second run of the Delphi. Two (2) indicators reached consensus and the other two were rejected (Table 7.26).

TABLE 7.26: LEVEL OF CONSENSUS ON THE IMPORTANCE OF SUPPLIER QUALITY MANAGEMENT IN PREVENTING FOOD WASTE (ROUND 2)

Supplier quality management	Consensus (% agreement)
There is a solid partnership with suppliers.	**66.7**
Written documentation from suppliers that quality management procedures and legislation are adhered to.	**66.7**
Supplier delivery equipment is frequently inspected.	83.3
Suppliers use packaging materials that provide adequate protection of food during transportation.	83.3

Panellists viewed building a solid partnership with suppliers unimportant in food waste prevention. Contrary to this, the literature (Theodorakioglou, Gotzamani & Tsiolvas, 2006: 149) indicates that a solid relationship or closer long-term relationship between suppliers and buyers 'imply the use of joint quality planning' (e.g. developing product specifications, use of quality control) and 'joint production planning (e.g. use of a JIT system) between buyer and supplier'. In this kind of close working relationship, it can be expected that suppliers will be involved in cooperative problem-solving, identification of appropriate and quality ingredients during recipe standardisation, responding to issues of quality problems identified by food service operators, and others that may lead to quality improvement of menu items, hence minimising food waste generation. Additionally, written documentation from a supplier that quality management procedures and legislation will be adhered to, was perceived as unimportant in food waste prevention. This result has not been previously described in the food service literature. However, it may be expected that the provision of written documentation serves as a form of open communication. The written documentation may help the food service operator (buyer) to establish the extent to which the supplier meets quality standards, and also makes the supplier aware of its current quality performance. Such documentation may result in the supplier responding to inadequacies, hence quality improvement, which may be expected to contribute to food waste reduction.

The findings indicate consensus on the importance of inspecting supplier delivery equipment in preventing food waste. It is important to inspect the suppliers' transport and delivery equipment in order to ensure that it supports optimal temperature control and food safety, to prevent food waste. In agreement with the findings, Mercier *et al*. (2017) argued that inspecting and ensuring that the transportation requirements for the delivery of food are met, is an important food quality and safety monitoring-measure that significantly contributes to food waste prevention. It was further agreed that the use of packaging materials that provide adequate protection for food during transportation was an important factor in food waste prevention. In support of this, Verghese, Lewis, Lockrey and Williams (2015) indicated that food waste can be reduced through the use of packaging that protects the products by preventing breakages, spoilage and contamination, and maintaining temperature control. However, the sustainability dimension of improved packaging systems suggests more packaging rather than less, which scores lower on environmental sustainability (Verghese *et al*. 2015).

In summary, **nine (9) indicators** of supplier quality management were validated as important in food waste prevention (Figure 7.6). A total of **two (2) indicators** were rejected and indicated as unimportant in food waste prevention in the University food service sector.

- *Information and analysis*

A total of seven (7) indicators were included in the second round of the Delphi survey. Three (3) of the seven (7) indicators (42.9%) reached consensus and four (4) (57.1%) failed to do so (Table 7.27).

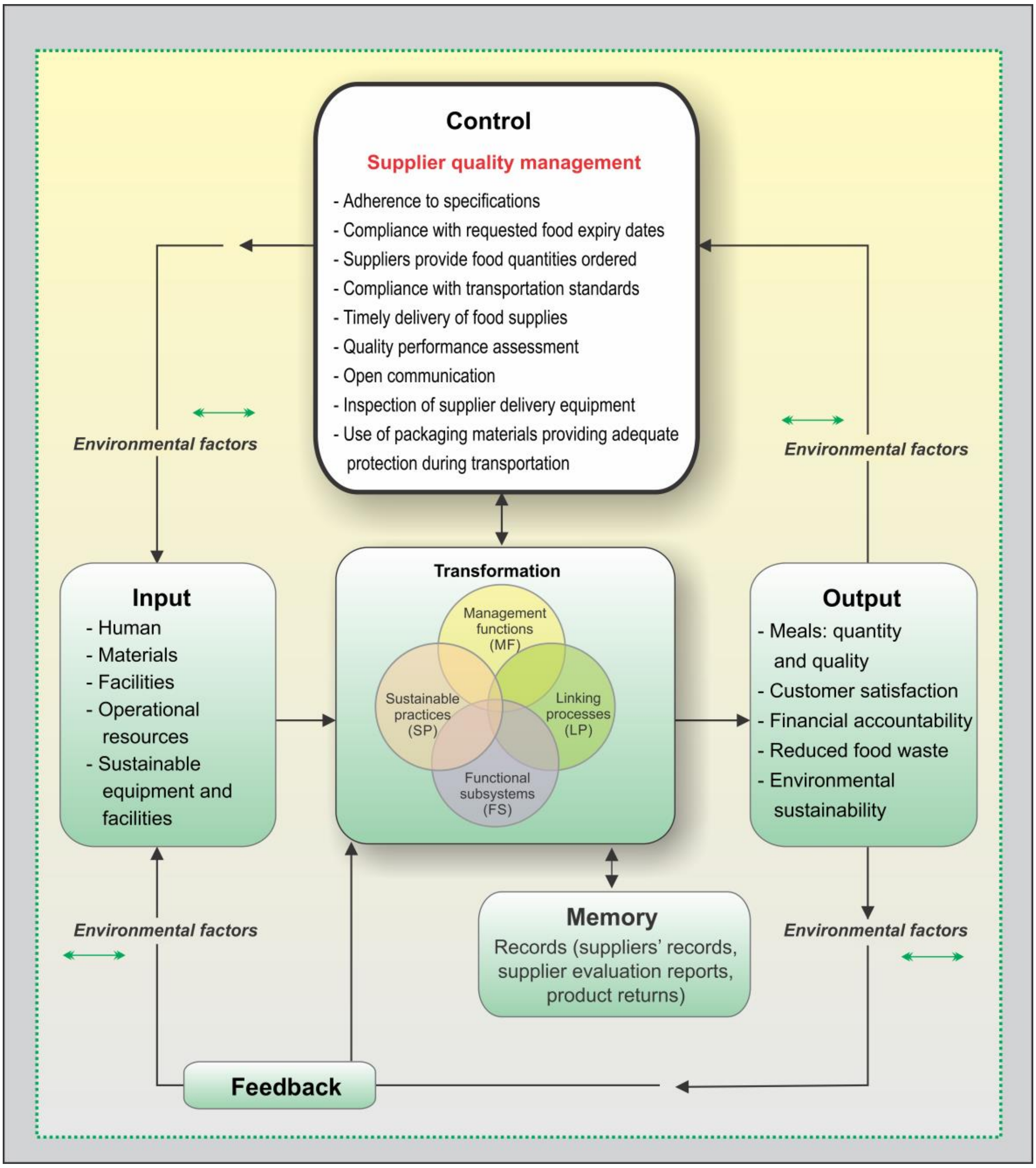


FIGURE 7.6: SUPPLIER QUALITY MANAGEMENT INDICATORS IN PREVENTING FOOD WASTE

TABLE 7.27: LEVEL OF CONSENSUS ON THE IMPORTANCE OF INFORMATION AND ANALYSIS IN PREVENTING FOOD WASTE (ROUND 2)

Information and analysis	Consensus (% agreement)
A variety of data collection methods are used to ensure reliability of quality performance data.	**66.7**
There is adequate storage for archiving information.	**50**
Easy retrieval of stored information.	**66.7**
Accurate data recording.	83.3
Information is readily available for analysis at any given time.	**50**
Analysed data is used to influence decisions.	83.3
Systems for tracking food waste and surplus are available.	83.3

The panel of experts failed to reach agreement on the importance of using a variety of data collection methods in preventing food waste. This indicator has not been discussed in previous literature. It may be argued that applying various data collection methods can ensure reliability of data; it may also be cumbersome for food service operations. An effective, automated information system may be ideal as it may facilitate managers' ability to respond quickly to rapid changes in the environment that may impact quality performance and waste generation (Mosadeghrad, 2014). Additionally, panellists considered adequate storage for archiving information unimportant in food waste prevention. It may be expected that an adequate information storage system that is computer-based, is important as it may ensure proper information management in that all historical records (**memory**) will always be available for all key users. In this way, records may always be available for analysis, and the organisation's current quality performance may be compared to past performances, hence informing quality improvement efforts. Contrary to findings, Kim *et al*. (2012) indicated that design processes tend to require much information and a wide range of data, which necessitates reliance on stored past records. This demonstrates the need for adequate information storage systems for quality improvement, and where quality is improved, food waste is reduced. Similarly, panellists failed to reach consensus on the importance of easy retrieval or access to stored information. It may be expected that easy retrieval of stored information may enable timely access of data and information for all key users. This may offer opportunities to identify and respond to processes that compromise quality and generate waste.

The results indicate consensus on the importance of recording data accurately in food waste prevention. In support of the results, Heikkilä *et al*. (2016) showed that accuracy in data recording is pivotal in quality management and food waste reduction, as it communicates an accurate picture of the quality problems affecting the organisation, hence it allows for objective analysis and decision-making based on true data. The availability of information for analysis at any given time was perceived as unimportant in food waste prevention. Contrary to the findings, Kim *et al*. (2012) indicated that the availability of updated information at any time that is shared across departments in an organisation, is an important strategy in being more responsive and timelier in improving processes. In this way, quality problems that may generate waste, may be attended to in time, hence reducing the repetition of errors that cause wastage.

There was consensus that using analysed data to influence decisions was a contributing factor in preventing food waste. Studies on total quality management (Kim *et al*., 2012; Psomas *et al*., 2016; Sadikoglu & Zehir, 2010) illustrated that successful implementation of the TQM approach requires managers to make decisions based on the analysis of relevant data and information. By relying on recorded information for the purpose of decision-making, an organisation is more likely to be more responsive and use quality data in pertinent processes that may affect food waste, such as when selecting a supplier, developing specifications and assessing supplier performance (Kim *et al*., 2012). The study further demonstrated consensus on the importance of the availability of systems for tracking food waste and any surplus. Reporting waste may provide management with an opportunity to develop mitigation measures to prevent food waste. Without a system for tracking food waste and a surplus, a true picture of the actual level of food waste generated may remain unknown and mitigation measures not developed.

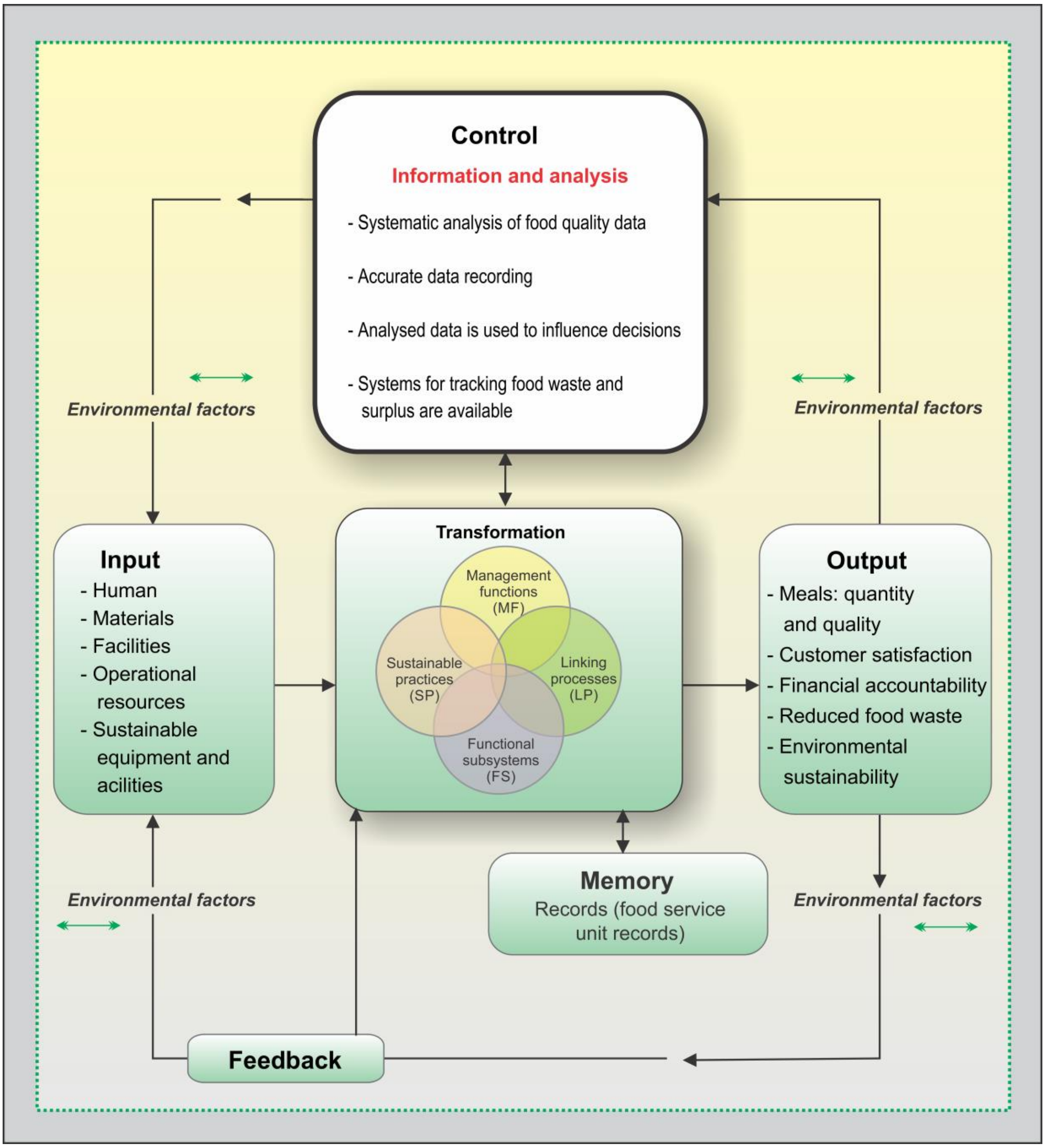


FIGURE 7.7: INDICATORS OF INFORMATION AND ANALYSIS CONTRIBUTING TO FOOD WASTE PREVENTION

In summary, **four (4) indicators** of information and analysis were validated as important in food waste prevention (Figure 7.7). A total of **four (4) indicators** were rejected and indicated as unimportant in food waste prevention in the University food service sector.

- *Process and product quality management*

This section discusses the indicators where agreement was reached and those that failed to do so in the second round of the Delphi, within each stage of the functional subsystem of the food service system.

⇒ Purchasing

Two (2) indicators of purchasing were included in the second run of the Delphi survey. Both of these reached consensus (Table 7.28).

TABLE 7.28: LEVEL OF CONSENSUS ON THE IMPORTANCE OF INDICATORS OF PURCHASING IN PREVENTING FOOD WASTE (ROUND 2)

Purchasing	Consensus (% agreement)
The expected amount of time before a food item should be purchased is forecasted	83.3
Changes in the menu are communicated in time to optimise ordering	83.3

The results show there is agreement on the importance of forecasting the expected amount of time before a food item will be purchased. This result might be explained by the fact that forecasting the time before a food item is purchased, might increase the accuracy of stock forecasting, hence avoids overstocking. Comparison of the findings with those of other studies (Charlebois *et al*., 2015; Moraes, Lermen & Echeveste, 2021) confirmed the importance of forecasting the expected amount of time before a food item should be purchased, as this is linked to the avoidance of overstocking and ordering appropriate amounts of food for a given period, hence preventing food waste. Notwithstanding this, its important to take into account that external factors such as competitors, weather conditions, events and others, may lead to fluctuations in the number of customers dining, hence affecting the expected amount of time before a food item is purchased. This may impact the stock levels and the possible generation of food waste. Panellists further agreed that communicating changes to the menu, on time, to optimise ordering, is an important factor contributing to the reduction of food waste. A possible explanation is that a change in the menu may necessitate a change in the order already placed with the supplier. By communicating the menu change, may curb wastage that may be caused by spoilage of ingredients in storage that are not used immediately.

The Delphi process validated all **seven (7) indicators** under the purchasing element.

⇒ Receiving

Only one (1) indicator failed to reach consensus in the first round of the Delphi and this was included in the second run of the Delphi. As shown in Table 7.29, panellists failed to reach agreement on the importance of scheduled deliveries in preventing food waste.

TABLE 7.29: LEVEL OF CONSENSUS ON THE IMPORTANCE OF INDICATORS OF RECEIVING IN PREVENTING FOOD WASTE (ROUND 2)

Receiving	Consensus (% agreement)
There are scheduled hours for receiving.	**66.7**

The panel of experts viewed scheduling hours for delivery as unimportant in food waste prevention. This is contrary to the findings of the qualitative phase (Section 6.5.8.2), which demonstrated that scheduled hours prevented food waste in that the availability of receiving-staff at the scheduled hours was guarenteed, which ensured prompt receiving and movement of stock to the appropriate storage areas, hence minimising food temperature abuse and food spoilage. However, it may also be argued that the delivery of food products as and when needed for production (Just-in-Time purchasing and delivery) and not necessarily at pre-scheduled hours is an important inventory management strategy that minimises ovestocking, hence food waste prevention (McAdams *et al*., 2019).

The Delphi process validated **seven (7) indicators** and rejected **one (1) indicator** under the receiving element.

⇒ Storage and inventory control

The second round of the Delphi included one (1) indicator that was rejected in the first round of the Delphi survey. The panel of experts still failed to reach agreement on the importance of adequate storage space in food waste prevention (Table 7.30 – next page).

The results indicate non-agreement on the importance of enough space for storage of all food-related items in food waste prevention. Contrary to the findings, it is expected that storage

TABLE 7.30: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATOR OF STORAGE AND INVENTORY CONTROL IN PREVENTING FOOD WASTE (ROUND 2)

Storage and inventory control	Consensus (% agreement)
Storage areas have enough space for storing all food-related items	**66.7**

facilities with enough space will enable food service workers to store all food items appropriately. According to Aamir, Ahmad, Javaid and Hasan (2018), enough space for storage of all food products, including overproduced menu items, is a critical factor in food waste prevention. However, this finding may suggest that the storage space alone may not ensure appropriate storage, but storage spaces need to be furnished with adequate and appropriate storage equipment for optimal storage of food products to support the quality and safety of food. Additionally, in situations where the food service unit applies the JIT delivery approach, and where supplies are delivered just before they are required for production, may lessen the need for ample food storage space.

At the end of the two runs of the Delphi, **thirteen (13) indicators** were validated as contributing factors in curbing food waste, and only **one (1) indicator** failed to reach consensus.

⇒ Issuing

The two (2) indicators that failed to reach consensus in the first round of the Delphi, and one (1), which was suggested by the panellists, were included in the second round of the Delphi. Two (2) of the three (3) indicators reached consensus, and one (1) failed to reach consensus (Table 7.31).

TABLE 7.31: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATOR OF ISSUING IN PREVENTING FOOD WASTE (ROUND 2)

Issuing	Consensus (% agreement)
A requisition form is used to issue food from storage to production	**33.3**
Requested items are measured using appropriate measuring equipment before issuance	83.3
Effective production planning enables issuance of the correct ingredients at the right quantities	83.3

The use of a requisition form to issue food from storage to production, failed to reach an agreement on the importance in food waste prevention. Contrary to the findings, a requisition plays an important role as a control of the goods removed from storage to production. It enables effective inventory management that contributes to food waste prevention, as only the required quantity of ingredients authorised by the production supervisor or manager, is issued (Kinasz *et al*., 2015). It is possible that panellists rejected this indicator, as it closely relates to the indicator on 'only the quantity of food needed as specified on an authorised production record is removed from the storage'.

It was agreed that the measurement of ingredients before issuing, was an important factor in preventing food waste. This is expected given the importance of accurate weighing and measuring of ingredients in the control of stock movement, and in quality food production. According to Filimonau *et al*. (2020), the measuring of requested ingredients is important as it ensures that accurate quantities of food are issued thus avoiding food waste, if excess ingredients beyond what is required, are issued. The panel experts further considered effective production planning as important in preventing food waste. A possible explanation for this is that effective production planning assists with food waste prevention, as it may be an important tool coordinating the flow of ingredients between storage and production.

The Delphi process validated **five (5) indicators** under issuing, and **one (1) indicator** was rejected.

⇒ Food production

All indicators of food production reached consensus in the first run of the Delphi process and therefore, there were no indicators to evaluate in the second round of the Delphi. In summary, all **eleven (11) indicators** under the food production element were validated as important in food waste prevention.

⇒ Distribution

Two (2) indicators were suggested by panellists in the first round of the Delphi. These were included in the second run of the Delphi and both indicators reached consensus (Table 7.32).

Panellists reached consensus on the importance of minimising the holding time between production / reheating and serving. Time control by minimising the holding time, is essential in controlling the growth of pathogenic microbes and ensuring safety, and retaining the quality

TABLE 7.32: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATOR OF DISTRIBUTION IN PREVENTING FOOD WASTE (ROUND 2)

Distribution	Consensus (% agreement)
Minimise holding time between production / reheating and serving.	83.3
Proper packaging of food distributed.	83.3

of the food, which in turn minimises the chances of food disposal (Al-Kandari *et al.,* 2019). It was further agreed that the proper packaging of food for distribution was an important factor contributing to food waste minimisation. This finding is in agreement to the findings of Verghese *et al*. (2015), who suggested that food packaging protects the food during distribution, which includes preventing breakages, spoilage and contamination thus having a significant impact on food waste reduction.

In summary, the validation phase supported **eleven (11) indicators** under the distribution element of the food service system.

⇒ Service

Two (2) indicators that failed to reach consensus in the first round of the Delphi, were included in the second round. Both indicators failed to reach consensus in the second round of the Delphi (Table 7.33).

TABLE 7.33: LEVEL OF CONSENSUS ON THE IMPORTANCE OF THE INDICATORS OF SERVICE IN PREVENTING FOOD WASTE (ROUND 2)

Service	Consensus (% agreement)
Standardised serving utensils are used for portioning.	**66.7**
Food is neatly plated and presented.	**66.7**

The panellists did not find using standardised portioning tools important in preventing food waste. As discussed in Section 6.5.8.7, it may be expected that the use of standardised portion control tools increases the precision and consistency in portion control (Gregoire, 2017:186) and thus reduces service waste. However, strict adherence to standardised portioning tools may limit flexibility in portioning, taking into consideration the customers' preferred portion size, hence plate waste. The findings further indicated disagreement on the importance of neat and attractive meal presentation in food waste prevention. This finding is contrary to previous studies (Betz *et al*., 2015; Ofei *et al*., 2014), which suggested that attractive meal presentation attracted customers to purchase meals, hence reducing food waste at the service point.

The Delphi process validated **nine (9) indicators** under service as important in preventing food waste, and **two (2) indicators** were rejected.

A total of **64 indicators** were validated under the dimension of process and product design that included the activities undertaken under the functional subsystem (Figure 7.8 – next page). A total of **five (5) indicators were rejected** under this dimension

7.5.2.3 Sustainability practices preventing food waste

This section presents the findings of the second round of the Delphi of the indicators of the sustainability practices to prevent food waste, which were validated as either important or considered as unimportant in waste prevention. The practices are discussed under the two (2) categories; environmentally focused sustainable practices and sustainable food practices.

7.5.2.3.1 Environmentally-focused sustainable practices

The results indicate lack of consensus on the importance of all nine (9) environmental-focused sustainable practices (Table 7.34).

TABLE 7.34: LEVEL OF CONSENSUS ON THE IMPORTANCE OF ENVIRONMENTALLY-FOCUSED SUSTAINABLE PRACTICES IN PREVENTING FOOD WASTE (ROUND 2)

Environmentally-focused sustainable practices	Consensus (% agreement)
Less energy consumption cooking methods are adopted.	**33.3**
Adherence to optimal cooking times.	**66.7**
Batch cooking.	**66.7**
Reduced food miles (distance food travels from the supplier to food service unit is reduced).	**50**
Reduction of the amount of water used during production.	**50**
Conservation of energy when cooking.	**50**
Kitchen with good ventilation.	**50**
Keeping cool air in refrigerator from going out and reduction of opening frequency.	**66.7**
Regular cleaning and maintenance of kitchen appliances.	**66.7**

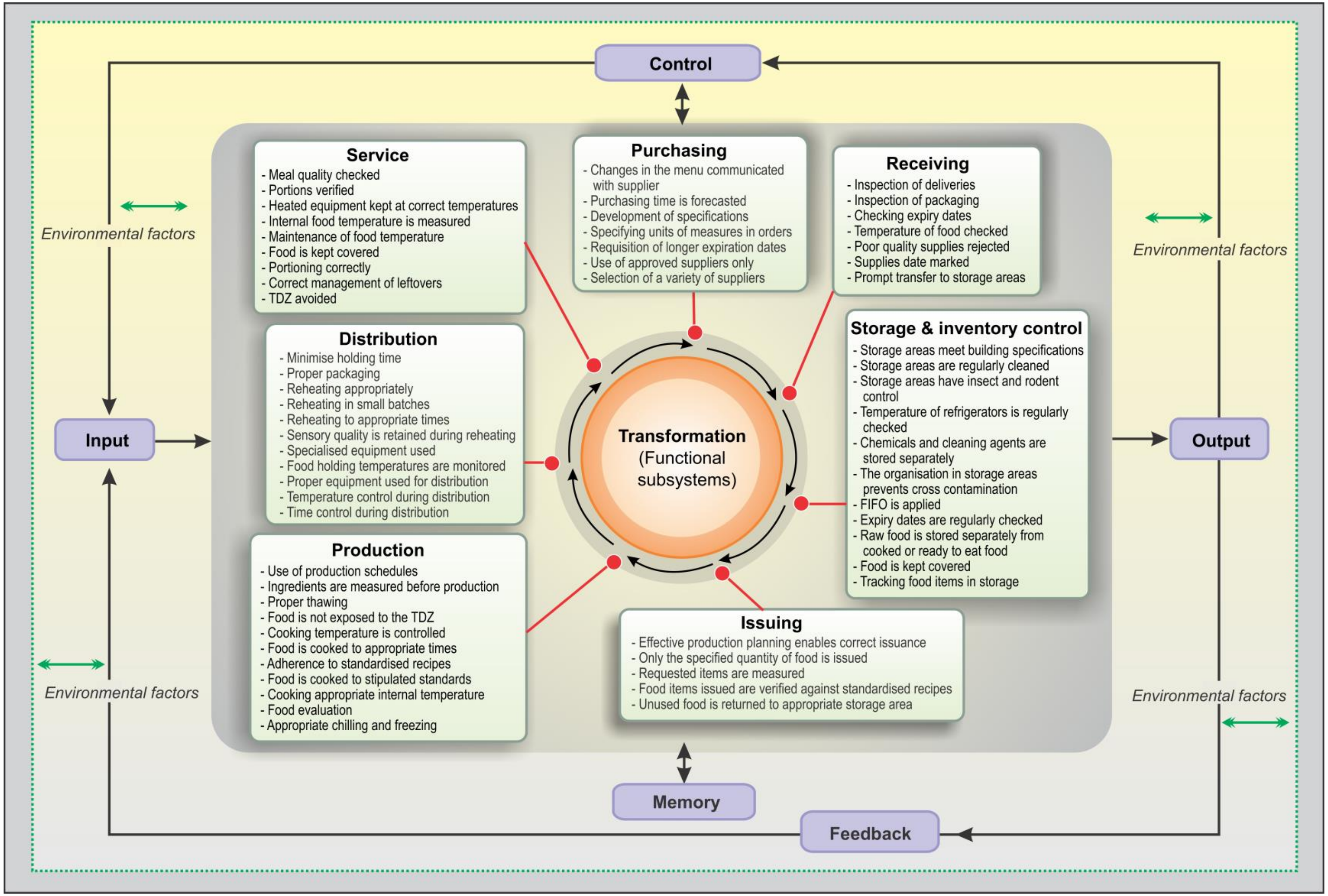


FIGURE 7.8: ADAPTED FOOD WASTE PREVENTION VALIDATED UNDER THE DIMENSION OF PROCESS AND PRODUCT DESIGN

According to the findings, the adoption of cooking methods that use less energy was considered unimportant in food waste prevention. The literature in this area has not established the link between the cooking methods that consume less energy and food waste. However, contrary to this finding, the qualitative phase of the study, revealed that quick cooking methods, such as steaming and frying, prevented food waste as they enabled the food service operation to prepare certain menu items on demand (cook-to-order), hence lessening the occurrence of overproduction. There was lack of agreement on the importance of adherence to optimal cooking times in food waste prevention. Contrary to the findings, it may be expected that the adherence to optimal cooking times, contributes to the production of quality menu items, avoids burning food and helps ensure the safety of food, hence food waste prevention. The findings of the study further revealed that panellists consider bulk food production unimportant in food waste prevention. A possible explanation is that bulk food production is energy efficient but may encourage overproduction of food, hence food waste. In agreement with the findings, Alcorn *et al*. (2020) indicated bulk food production versus cooking in small quantities creates kitchen waste.

The panel of experts considered reduced food miles as an unimportant factor in reducing food waste in the University food service operations. This outcome is contrary to that of Frash *et al*. (2015), who showed that the supply of transporting food over a short distance retained the quality of food compared to over long distances thus keeping food fresh for longer and reducing food waste. A possible explanation for this result, is that the transportation of food over a long distance is done under controlled conditions, such as adequate ventilation and a cold environment, hence maintaining quality and safety thus food waste reduction.

According to the panellists, limiting the use of running water was not important in food waste reduction. This is contrary to the qualitative findings, which showed the use of running water wasted food, for example, where rice was washed under running water, some grains were washed away. Additionally, the reduction of the amount of water used or the use of just enough water during food production as specified in the standardised recipes, was not considered important in food waste reduction. This result is unexpected given that where more water than required is used, the quality and consistency of food is affected, which is expected to contribute to food waste generation.

The conservation of energy during cooking was considered not important in food waste prevention. Energy conservation during food preparation, includes such practices as covering pots while cooking, switching off cooking hoods when not in use and using energy-saving devices (Oberascher, Stamminger & Pakula, 2011). Contrary to this result, findings from the qualitative phase (Chapter 6, Section 6.6.1) illustrated that the adoption of energy conservation methods during cooking, helped with the production of good quality products, hence food waste reduction. It was further indicated that a well-ventilated kitchen was not considered an important factor in food waste prevention. This area has not been documented in previous literature; however, a link has been made between well-ventilated storage areas and food waste reduction (Rostami *et al*., 2020). Contrary to findings, it was expected that a well-ventilated kitchen would preserve the quality and safety of food thus contributing to food waste prevention. Panellists did not reach consensus on the importance of keeping cool air in the refrigerator and not letting it out by reducing the frequency of opening. This is contrary to the findings of Rodriguez-Martinez, Velazquez, Massa-Barrera, Welti-Chanes, Fagotti and Torres (2019), who showed that the length of time and the number of times a refrigerator door was opened, may lead to food quality losses. Quality degradation may result in food being discarded.

Panellists considered regular cleaning and maintenance of kitchen appliances unimportant in food waste prevention. The contribution of the cleaning and maintenance of kitchen appliances to food waste has not been investigated in previous research. However, this is contrary to expectations, as it may be suggested that the cleaning and maintenance of kitchen appliances may prevent the infestation of insects, and avoid malfunctioning of the appliances during food production, hence food waste prevention.

At the end of the two runs of the Delphi process, no **(zero)** indicator under environmental-focused were validated as important in preventing food waste, and **nine (9) indicators** were rejected. The rejection of these indicators may to an extent reflect limitations of potential items. Some indicators were ambiguous and had alternative meaning, which might have caused confusion among panellists. For example, the term batch cooking can be interpreted as producing food in a large quantity all at once, then storing it in portions for later use or as cooking smaller quantities of menu items as required for service.

7.5.2.3.2 Sustainable food practices

The results show that panellists reached agreement on three (3) sustainable food practices, and four (4) indicators were rejected (Table 7.35 – next page).

This study was unable to demonstrate that the use of locally sourced ingredients contributes to food waste prevention. The outcome is contrary to that of Frash *et al*. (2015), who suggested

TABLE 7.35: LEVEL OF CONSENSUS ON THE IMPORTANCE OF SUSTAINABLE FOOD PRACTICES IN PREVENTING FOOD WASTE (ROUND 2)

Sustainable food practices	Consensus (% agreement)
Use of locally sourced ingredients.	**66.7**
Purchase and utilisation of food in season.	83.3
Purchase and utilisation of organic food.	100
Use garnishes to a limited extent.	**16.7**
Make changes in the menu to adapt to available products.	**66.7**
Traceable food supply chain.	**33.3**
Follow the food safety and sanitation regulations.	83.3

that sourcing ingredients locally, lessened food wastage that may have occurred due to food spoilage, as the food products stayed fresh longer because the transportation times were reduced. Also, it may be expected that sourcing ingredients locally may enable food service operators to purchase some ingredients as and when they are needed (Just-in-Time delivery), hence reducing the chances of food waste due to overstocking or keeping food for a long time in the storage areas.

The findings show agreement that purchasing seasonal food is an important factor in food waste prevention. This finding agrees with that of Feagan *et al*. (2004), who suggested that seasonal foods have better quality, taste and are fresher than those produced out of season. As discussed in Chapter 6, Section 6.6.2, the better quality of seasonal ingredients results in better customer acceptance of menu items produced from these, and food spoilage during storage may be reduced. The panel of experts further reached consensus on the importance of using organic food in waste prevention. This is in agreement to the qualitative findings from the second phase of the study (Chapter 6, Section 6.6.2), which indicated that organic food products generate less waste due to their premium quality.

The limited use of garnishes was viewed as unimportant in food waste prevention. A possible explanation for this might be that eliminating the use of garnishes all together might be a better strategy for food waste reduction rather than limiting the use. According to Von Massow and McAdams (2015), in many cases where garnishes were used, they were almost always wasted and therefore, by eliminating such garnishes, prevented food waste. The panel of experts did not find flexible menu planning, based on available products, important in food waste prevention. This outcome is contrary to that of Betz *et al*. (2015), Derqui *et al*. (2016) and Filimonau *et al*. (2020), who suggested that making changes to the menu to incorporate food items nearing the expiry date, contributed to the prevention of food waste at the storage point. The traceability of the food supply chain was considered unimportant in food waste prevention. Contrary to the findings, according to George, Harsh, Ray and Babu (2019) the traceability of the food supply chain enhances the food safety and quality of food delivered to food service operations. It may thus be expected that food safety and quality control, curb food waste generation. The panel of experts reached consensus on the importance of having food safety and sanitation regulations in food waste prevention. In agreement with this, Okumus *et al*. (2020) mentioned that following food safety regulations curbs food waste that could occur due to contamination, particularly with perishable foods.

The Delphi process validated **five (5) indicators** under sustainable food practices as important in preventing food waste, and **four (4) indicators** were rejected. Figure 7.9 illustrates a summary of the sustainable practices that were validated as contributing to preventing food waste in the food service system.

FIGURE 7.9: INPUT-OUTPUT MODEL OF SUSTAINABILITY PRACTICES AND FOOD WASTE PREVENTION

7.5.2.4 Summary of Delphi round 2

The second run of the Delphi, included indicators which failed to reach consensus in the first Delphi round, as well as additional indicators which were suggested by panellists. Under total quality management practices a total of **49 indicators were included**. The results indicated that a total of eight (8) dimensions of the total quality management practices; **27 indicators reached consensus** at the end of the second round of the Delphi, whilst **22 TQM indicators failed to reach consensus**. A total of **17 indicators of sustainability practices were included** in the second run of the Delphi. Under sustainability practices, one (1) of the two (2) dimensions reached consensus, only **three (3) indicators reached consensus** and a total of **fourteen indicators failed to reach consensus** in the second round. This is illustrated in Table 7.34 (next page).

TABLE 7.34: SUMMARY OF DELPHI ROUND 2 RESULTS

Components	**Dimensions**	***n* (total indicators in Delphi survey 2)**	***n* (reached consensus)**	***n* (failed consensus)**
TQM Practices	Quality practices of top management	5	5	0
	Customer focus	5	1	4
	Employee management and involvement	7	5	2
	Process quality management	4	2	2
	Employee knowledge and education	6	3	3
	Supplier quality management	4	2	2
	Information and analysis	7	3	4
	Process and product quality design			
	Purchasing	2	2	0
	Receiving	1	0	1
	Storage and inventory control	1	0	1
	Issuing	3	2	1
	Production	0	0	0
	Distribution	2	2	0
	Service	2	0	2
	TOTAL NUMBER OF TQM INDICATORS	**49**	**27**	**22**
Sustainability practices	Environment focused practices	9	0	9
	Food focused practices	7	3	4
	TOTAL NUMBER OF SUSTAINABILITY INDICATORS	**16**	**3**	**13**

7.6 PRESENTATION OF THE VALIDATED TOOL FOR ADDRESSING FOOD WASTE IN THE UNIVERSITY FOOD SERVICE SECTOR

The study sought to validate the total quality management tool integrating sustainability practices, developed to address food waste in the university food service system. As illustrated in Table 7.35 below, a total of eight dimensions and 114 indicators of total quality management practices were validated as important in food waste prevention. Under sustainability practices, only one of the two dimensions reached consensus (food focused sustainability practices) and five indicators reached agreement on importance in food waste prevention. This is an indication that some sustainability practices may reduce the negative environmental impact but not necessarily prevent food waste.

TABLE 7.35: THE VALIDATED TOOL FOR ADDRESSING FOOD WASTE

Components	Dimensions	Indicators
TQM practices	Quality practices of top management	1. Management actively participates in quality improvement efforts. 2. Management holds regular meetings to discuss quality related issues. 3. Management supports quality improvement efforts by providing the necessary resources. 4. Food quality policy is taken into consideration in strategic planning. 5. Food quality data is taken into consideration in decision-making. 6. Food quality results are evaluated to check improvements. 7. Management gives priority to food production processes. 8. Food quality policy is communicated throughout the food service unit. 9. Management gives employees authority to manage food quality problems. 10. Management sets food quality strategies for employees. 11. Management liaises with personnel to get their input regarding quality policies and their implementation.
	Customer focus	1. There is a process of collecting customer feedback. 2. Customers' suggestions are recorded and analysed. 3. Food service unit is in close contact with customers.
	Employee management and involvement	1. Employees participate in food quality improvement activities. 2. Employees are motivated to improve food quality performance. 3. Employees take initiatives during their work processes to solve problems that would impact on food quality. 4. Employees' suggestions on food quality assurance are adopted. 5. Employees recognise superior quality performance. 6. Employees are evaluated on how well they ensure food quality. 7. Systems exist for promoting teamwork across the food service system. 8. Approaches to work promote open communication between departments and food service units. 9. Change management of personal attitudes of employees towards quality management and waste. 10. Employees are provided with feedback on performance to encourage continuous improvement.

Components	Dimensions	Indicators
	Process quality management	1. Critical processes are determined and evaluated. 2. Determination of areas, processes and points for improvement. 3. Specific organisational structures have been formulated to support quality improvement. 4. All employees are provided with work instructions. 5. Mistakes are precluded in the process design. 6. Benchmarking of quality management practices. 7. Hazard Analysis and Critical Control Points (HACCP) system is put in place. 8. Good Manufacturing Practices (GMPs) are put in place.
	Employee knowledge and education	1. Employees have the knowledge and know-how related to food service. 2. Resources are provided for staff training. 3. Employees are offered quality orientated training. 4. Training newly appointed staff members prior to assumption of duty. 5. Training employees in all control measures to minimise waste.
	Supplier quality management	1. Adherence of suppliers to food quality specifications. 2. Suppliers comply with requested food expiry dates. 3. Suppliers provide food quantities ordered. 4. Suppliers comply with the transportation standards for perishable and non-perishable foods. 5. Timely delivery of food products by suppliers. 6. Monitoring and assessing quality performance of suppliers. 7. Open communication between the food service unit and suppliers. 8. Supplier delivery equipment is frequently inspected. 9. Suppliers use packaging materials that provide adequate protection of food during transportation.
	Information and analysis	1. There is systematic analysis of food quality data. 2. Accurate data recording. 3. Analysed data is used to influence decisions. 4. Systems for tracking food waste and surplus are available.
	Process and product quality design	*Purchasing* 1. The expected amount of time before a food item should be purchased is forecasted. 2. Food specifications are developed. 3. Units of measure are specified in purchasing orders. 4. Particular expiry dates are requested when purchasing food items. 5. Only approved suppliers of food are selected. 6. Select and establish a variety of suppliers to ensure supply options. 7. Changes in the menu are communicated in time to optimise ordering.
		Receiving 1. Deliveries are inspected for quantity, against purchase order and invoice. 2. Deliveries are inspected against quality specifications. 3. Deliveries are checked to ensure undamaged packaging. 4. Expiry dates of deliveries are checked. 5. Temperature of perishable food is checked upon delivery. 6. Food items that do not meet quality specifications are rejected. 7. All newly received food items are date marked. 8. Received food items are promptly transferred to appropriate storage areas.

Components	Dimensions	Indicators
		Storage and inventory control 1. Storage areas meet specifications for walls, ceilings, floors, windows, baseboards, floor drains, lightning and ventilation. 2. Storage areas protect food from direct sunlight, heat, moisture and smoke. 3. Storage areas are regularly cleaned. 4. Storage areas have insect and rodent control. 5. Temperature of refrigerators is regularly checked. 6. Chemicals and cleaning agents are stored separately from food items. 7. The organisation of food items in storage areas prevents cross contamination. 8. The FIFO (First-In, First-Out) rotation system is applied at all times. 9. Expiry dates of food items are regularly checked. 10. Raw food is stored separately from cooked or ready-to-eat food. 11. Food is always kept covered. 12. A continuous track of food items held in storage is kept. 13. Relative humidity of refrigerators is regularly checked.
		Issuing 1. Only the quantity of food needed as specified on an authorised production record is removed from the storage. 2. Food items issued are checked against standardised recipes before production. 3. Unused food is returned to appropriate storage area. 4. Requested items are measured using appropriate measuring equipment before issuance. 5. Effective production planning enables issuance of the correct ingredients in the right quantities.
		Production 1. Use of production schedules. 2. Ingredients are accurately measured with appropriate measuring equipment. 3. Food items requiring thawing are properly thawed. 4. Food is not exposed to the temperature danger zone for more than four (4) hours. 5. Cooking temperatures are properly controlled during production. 6. Food is cooked to appropriate cooking time. 7. Standardised recipes are adhered to during production. 8. Food is cooked to appropriate, stipulated quality standards. 9. Food is cooked to appropriate internal temperature. 10. An appropriate procedure is followed for chilling and freezing food. 11. Food is evaluated for quality prior to meal service.
		Distribution 1. Specialised equipment with approved temperature controls are used. 2. Food holding temperatures are monitored. 3. An appropriate procedure is followed for reheating food. 4. Reheating is done in small batches. 5. Frozen food is reheated to appropriate service temperature. 6. Sensory quality is retained during reheating. 7. Proper equipment is used for distribution. 8. Temperature of food is properly controlled. 9. Time at which food is held under distribution is controlled. 10. Minimise holding time between production / reheating and serving. 11. Proper packaging of food distributed.

Components	Dimensions	Indicators
		Service 1. Front of house staff check quality of food before service. 2. Portions of food are verified upon receipt from back of the house. 3. Bain-Maries, chaffing dishes and heated cabinets are kept at correct temperatures. 4. Internal food temperature is measured and recorded. 5. An appropriate food temperature is maintained during service. 6. Food is kept covered until service. 7. Portioning is done correctly. 8. Proper management of surplus food. 9. The amount of time food is held under temperature danger zone is highly controlled.
Sustainability practices	*Food focused practices*	1. Purchase and utilisation of seasonal food. 2. Purchase and utilisation of organic food. 3. Utilisation of leftovers. 4. Cook to order. 5. Follow the food safety and sanitation regulations.

7.7 TQM PRACTICES, FOOD WASTE MANAGEMENT APPROACHES AND SUSTAIN-ABILITY

The two runs of the Delphi process applied in this study, validated TQM and sustainability practices, which were considered as important contributing factors to food waste prevention. The indicators that were validated, fall within the first tier of the food waste hierarchy – i.e. prevention, as illustrated in Figure 7.10.

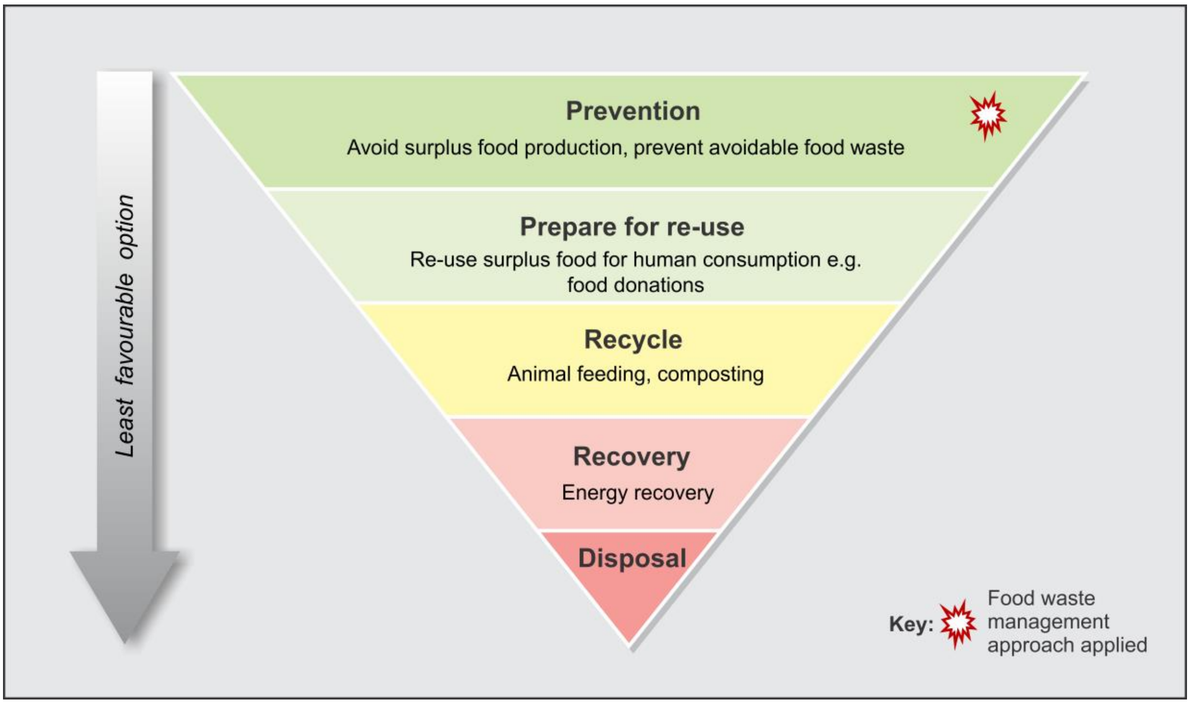


FIGURE 7.10: THE INDICATORS VALIDATED FALL WITHIN THE PREVENTION APPROACH OF WASTE MANAGEMENT

This is the most preferred food waste management approach, with the least negative impact on the environment. As indicated by numerous literature sources (Dou *et al*., 2016; Garcia-Garcia *et al*., 2015; Mourad, 2016; Papargyropoulou *et al*., 2014; Priefer *et al*., 2016), the prevention of food waste benefits the environment and is the most sustainable food waste management option.

7.8 SUMMARY

The results from the third phase of the study indicate that a total of **eight (8) dimensions** of total quality management practices, and **114 indicators were validated** as important in preventing food waste. A total of **22 indicators** of total quality management **were rejected**. With regards to sustainability practices, **one (1) dimension** of the two (2) (sustainable food practices) and **five (5) indicators were validated** as important in preventing food waste, and **13 indicators were rejected**. This is illustrated in Figure 7.11 (next page).

Figure 7.12 illustrates total quality management practices (**control**) validated as contributing to preventing food waste in the food service system. These practices ensured food quality and safety in all the aspects of the operations, thus preventing food waste, achieving the appropriate quantity and quality of meals, customer satisfaction, cost reduction and environmental sustainability (**output**). The study demonstrated the importance of sustainable ingredients and practices in preventing food waste. Records of the food service unit (**memory**) and **feedback** mechanisms were critical in providing information that was used to improve the quality of processes and products, and to reduce food waste.

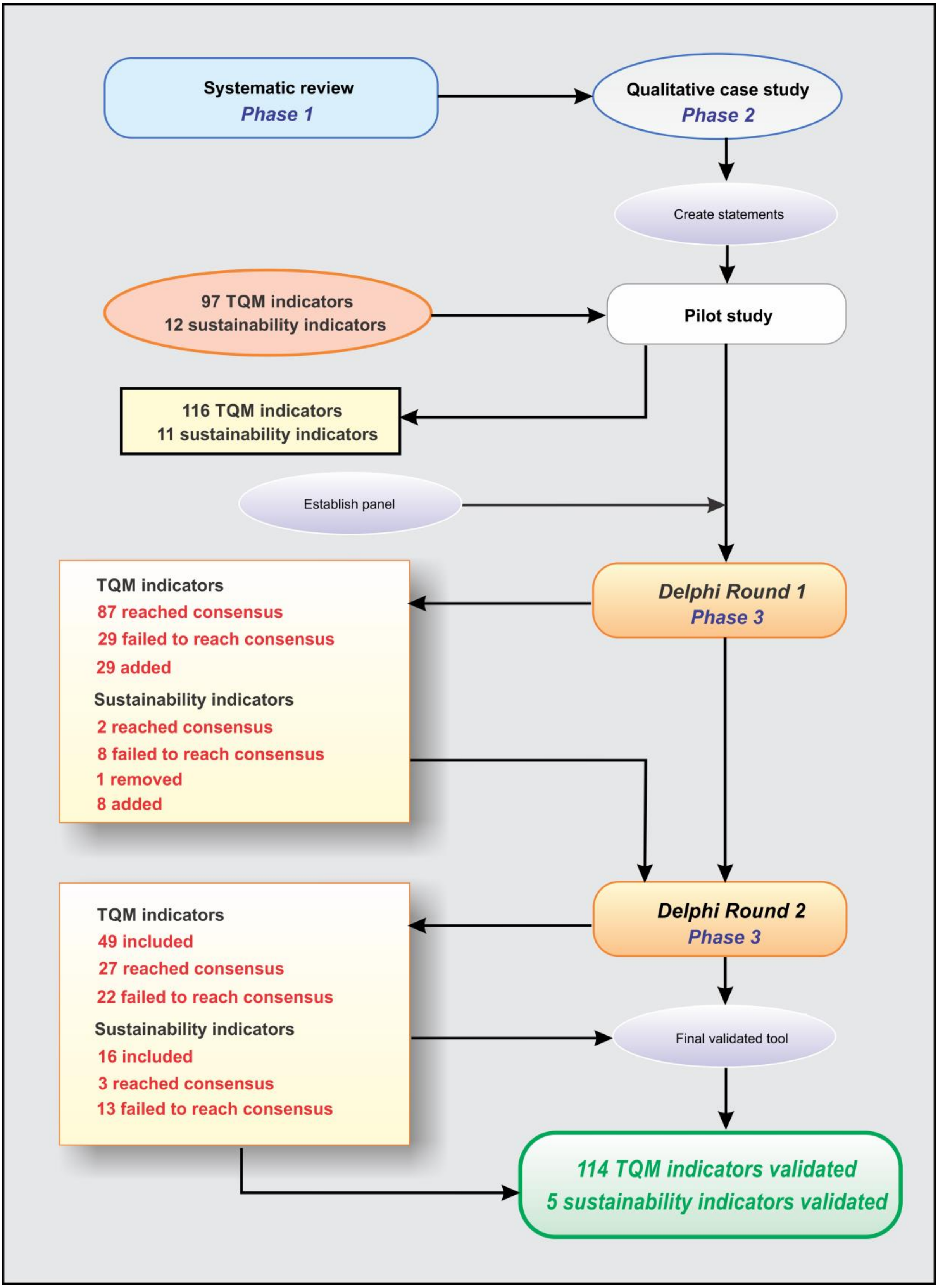


FIGURE 7.11: SUMMARY OF THE DELPHI PROCESS AND INDICATORS VALIDATED

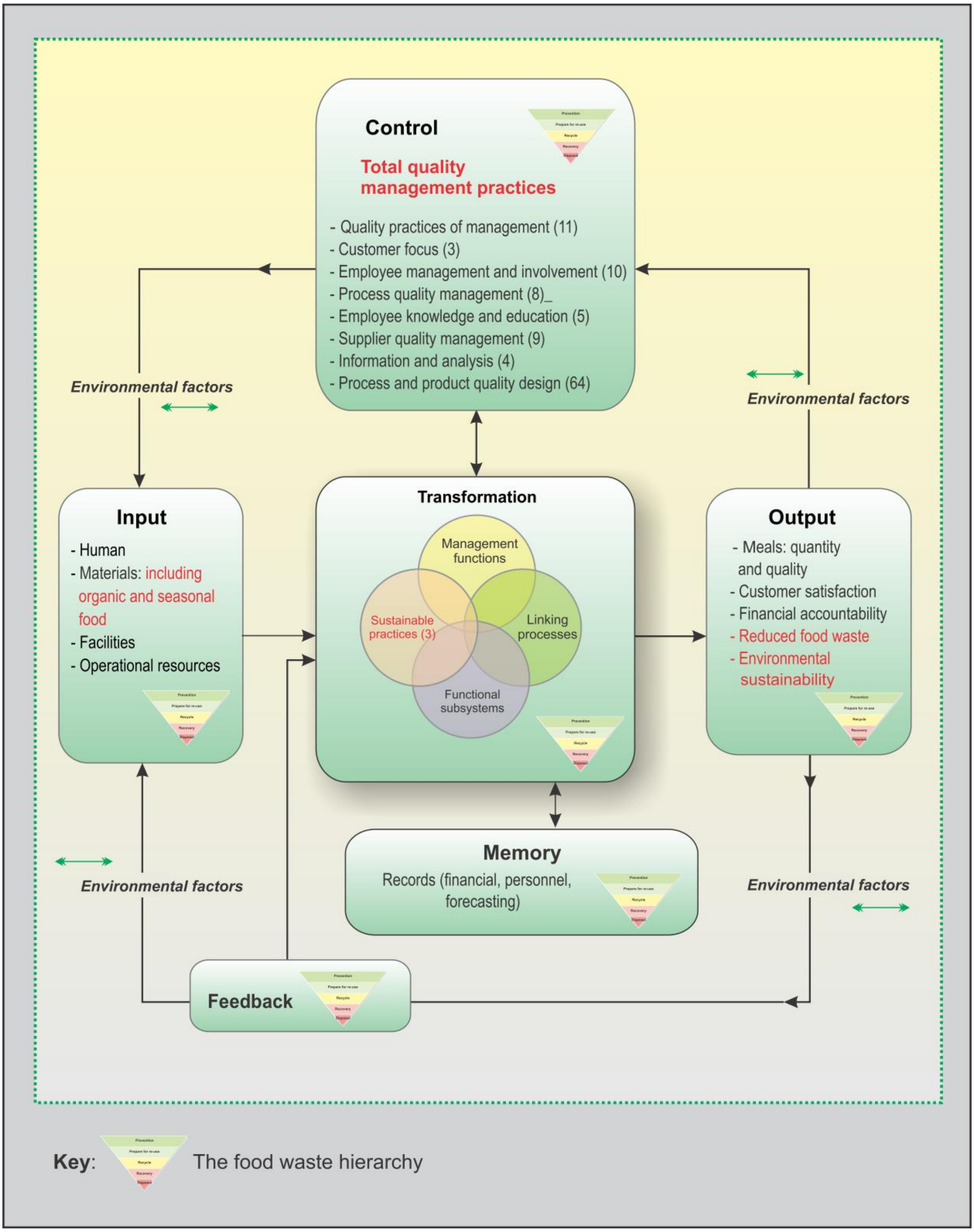


FIGURE 7.12: TQM PRACTICES AND SUSTAINABILITY PRACTICES CONTRIBUTING TO FOOD WASTE PREVENTION IN THE FOOD SERVICE SYSTEM

Chapter 8:

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

Chapter 8

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

This chapter commences with an overview based on the main constructs of the study, followed by the final theoretical framework applied, and a reflection on the methodological approaches. The conclusions are made, theoretical, methodological and practical contributions of the study are discussed, and limitations and recommendations for further study are made.

8.1 OVERVIEW OF THE STUDY

This section gives an overview on food waste as a global challenge, the issue of food waste in the context of university food service units, as well as in the specific geographical context of South Africa. Total quality management practices and sustainability practices as measures to prevent food waste, are reflected upon.

8.1.1 The global challenge of food waste

In this study, food waste was conceptualised as the loss or disposal of edible parts of food intended for human consumption at some point along the food service system. The issue of food waste has gained increasing attention worldwide, with growing concern for its environmental, social and economic impact (Goonan *et al*., 2014). The literature (FAO, 2015; Gustavsson *et al*., 2011; Oelofse & Nahman, 2013) on food waste has generally indicated that a substantial amount of food is wasted; at least 1.3 billion tonnes of food globally per year (Gustavsson *et al*., 2011). The distribution of food losses and waste varies between developed and developing countries, and across the food supply chain (Gustavsson *et al*., 2011; Lundqvist *et al*., 2008). Generally, developed countries are facing relatively greater challenges with the magnitude of food waste than developing countries. Furthermore, in developing countries, the larger proportion of food waste is generated at the beginning of the food value chain, whereas in developed countries, major losses occur at the end (Betz *et al*., 2015). Notwithstanding this, the magnitude of food waste at the end of the food value chain in some developing countries, in particular South Africa, is worrisome. On a per capita basis, 210 kg per capita of food waste is generated per year in South Africa (WWF, 2017), which is higher than in developed countries (107 kg/year). The magnitude of the problem of food loss and waste in South Africa varies across the food supply chain. The review of the literature indicated that few empirical studies, which quantify food waste generated in food service operations, have been conducted. Most studies on food waste in South Africa focused on household food waste (Cronjé *et al*., 2018; Oelofse *et al*., 2018; Oelofse & Marx-Pienaar, 2016; Ramukhwatho *et al*., 2018). Only two studies could be found that focused on food waste in university food service operations (Marais *et al*., 2017; Painter *et al*., 2016). From these studies, it was found that a substantial amount of food waste was generated in university food service operations, and further causes in this context were discussed. The current study therefore, adds knowledge to the limited literature on food waste in the context of a South African university's food service units. The next section gives an overview on food waste in a particular university's food service units.

8.1.2 Food waste in a university's food service units

The empirical research showed trends of appreciable food waste at institutions of higher education across the world. Several studies have documented food waste in the context of universities, mostly in the United States of America, as discussed in Chapter 3, Section 3.3.2.5. In the context of South Africa, two empirical studies have been conducted to establish the magnitude of food waste generated at Rhodes University and Stellenbosch University. A study conducted by Painter *et al*. (2016) reported that an estimation of 555 gm of food waste per student was generated on a daily basis at Rhodes University, which translated to about 450 tonnes of food waste per year. This estimation indicated that food waste generated at Rhodes University is strikingly higher than an average amount of food waste generated by most universities. On the other hand, the results of the study undertaken by Marais *et al*. (2017), at Stellenbosch University residential food service units, indicated that 26.7% of food was discarded. This was a much higher percentage of food wasted, compared to 9.65% in a German university canteen (Betz *et al*., 2015). Given the magnitude of the problem, the study developed a tool to address food waste in the university food service system, both locally and abroad.

Prior to the development of the tool to address food waste, an identification and understanding of the causes of food waste was necessary. The review of the literature showed that there were limited studies, which have investigated these from the systems' perspective. The study therefore, investigated the causes of food waste in the university food service sector from a systems perspective. This disentangled the complexity and diversity of the causes of food waste, and in so doing, enabled the researcher to realise a holistic approach to addressing food waste.

8.1.3 Total quality management practices and sustainability practices as measures to prevent food waste

Previous research has given attention to examining the relationship between total quality management practices and performance (Agus & Hassan, 2011; Kaynak, 2003; Patiar *et al*., 2012; Sadikoglu & Olcay, 2014; Topalović, 2015), total quality management and innovation (Kim *et al*., 2012; Prajogo & Sohal, 2003), as well as total quality management and customer satisfaction (Kristianto *et al*., 2012; Mehra & Ranganathan, 2008; Topalović, 2015). Little attention has been given to examining the influence of TQM practices on the generation or prevention of food waste. This study closed this literature gap and showed that TQM practices can contribute to the prevention of food waste in university food service units.

Additionally, the study explored the potential contribution of sustainability practices in preventing food waste in the University's food service units. Although there is a growing awareness and attention to sustainability practices (Pinard *et al*., 2014), the previous literature shows limited evidence on the potential of sustainability practices to address food waste in the context of food service units. Empirical research on sustainable food systems has largely focused on agricultural food production practices; it rarely addressed sustainability in food service units and its potential impact on food waste. The limited literature available on sustainability in the context of food service operations has no clear focus on integrating sustainable practices in the food service system in a way that also leads to the reduction of food waste (Bloemhof *et al*., 2015; Dauner *et al.,* 2011). This study closed this theoretical gap and demonstrated that a number of sustainable practices contributed to both the reduction of food waste in the food service system and potentially reduced the negative environmental impact.

The TQM and sustainability practices that were considered as preventative measures of food waste in the food service units, fell within the first and most preferable tier of the waste hierarchy – prevention.

The next section discusses the theoretical framework that provided the theoretical foundation for this study.

8.2 FINAL THEORETICAL FRAMEWORK FOR THE STUDY

The **systems theory** was applied to investigate and address the problem of food waste in the University food service system. The study focused on the entire food service system by conducting an in-depth investigation on how each part of the system or subsystems and their interrelatedness contributed to food waste generation. The study further developed a total quality management tool (in the control element) that prevents food waste. Sustainability was integrated into the systems model, with an indication of sustainable inputs, sustainable practices that prevent food waste in the transformation subsystem and sustainable outputs. In line with the objectives of the study, i.e., to prevent food waste in the University food service units, the study applied the **food waste hierarchy framework** and adopted 'prevention', which is the most favourable and environmentally sound food waste management option. The sustainable practices to address food waste in the University food service units are in line with the environmental dimension of the **triple bottom line framework** of sustainability. The theoretical framework that guided the study was discussed in depth in Chapter Two (2) and illustrated in Figure 2.25. The present study showed how the systems model can be applied to address the issue of food waste, and thus offered a more holistic approach to food waste management. Additionally, the waste hierarchy and triple bottom line framework were integrated into the existing systems model and therefore, emphasised a more sustainable and preventative approach to address food waste.

The next section reflects on the methodological approach that was followed in this study.

8.3 REFLECTION ON METHODOLOGICAL APPROACHES

In this study, a multiphase mixed methods design with both exploratory and explanatory strands was applied. A three-phase (predevelopment, developmental and validation phases) tool development process was followed. The multiphase mixed methods design was appropriate for the study; the iterative process contributed to the development of a tool that comprehensively covered relevant dimensions and constructs. Each phase of the data collection informed the conceptualisation and application of the subsequent phase, with the ultimate goal of answering the main objective of the study, as well as refining the constructs of the tool developed. The application of a mixed methods approach contributed to the triangulation of the data and served as a cross-validation technique that enhanced the trustworthiness (i.e., 'truth value') of research findings. This section of the chapter reflects on the methodological approach at each phase of the study, considers how effective the methodological approach was in answering the research questions, the benefits and disadvantages of each approach and their contributions to the study.

8.3.1 Predevelopment phase – systematic review

A systematic review of the literature was conducted and this contributed to the exploration and conceptualisation of dimensions and indicators of total quality management and sustainability practices that prevented food waste. The systematic review helped to reduce time delays as it allowed the researcher to explore dimensions and indicators within a relatively short period of time (compared to a qualitative data collection timeframe). Through the adoption of search strategies, predefined search terms and predetermined inclusion and exclusion criteria (discussed in Chapter 4, Section 4.5), implicit researcher bias was reduced, which yielded reliable and accurate findings. Despite the benefits of the systematic review approach, a number of practical problems were encountered throughout the process. Access to some of the published literature not subscribed to by the University, was a challenge. To overcome this, the Subject Librarian was consulted and she was able to access the restricted articles. Another challenge was the limited literature in the context of food service units and therefore, this limited generalisability to food service operations. This necessitated conducting a qualitative study in the specific context of food service operations.

8.3.2 Developmental phase – qualitative case study approach

A qualitative case study approach was applied in the second phase of the study to gain a deeper understanding of the dimensions and indicators of total quality management and sustainability practices that prevented food waste in the specific context of the University food service units. The data collection process involved an integration of four different techniques, including document analysis, face-to-face interviews, focus group discussions, and participant observation. This section reflects on the sampling strategy applied, the qualitative data collection methods used, data analysis, and the trustworthiness of the findings.

8.3.2.1 Sampling

The study area was conveniently and purposively selected as it was the largest residential food service unit of the University. Given the magnitude of the food service unit and the large number of food service personnel, the researcher was able to obtain a wider range of viewpoints which maximised the depth of data on quality management practices, sustainability and food waste.

A purposive sampling strategy was applied to select the participants for the study. The criteria for the selection of participants were set at the outset of the investigation to include members of management at the food service unit, as well as back-of-house and front-of-house food service workers. This strategy was appropriate as it enabled the researcher to select participants who had experience in the University food service unit, and previous involvement with total quality management practices, sustainability practices and food waste. In-depth knowledge that answered the objectives of the study was obtained, as the participants were selected on the strength of their defining characteristics as holders of the data needed for the phenomenon that was investigated.

8.3.2.2 Data collection techniques

- *Document analysis*

The document analysis technique involved reviewing and evaluating organisational documents or records, such as weekly reports on food production, meal statistics and food waste, as well as financial reports, which covered the amount, causes and cost of food wasted, and the records to do with procurement, receiving, inventory, production and service. Inclusion and exclusion criteria were set and this practice enhanced the quality of the document analysis process and the findings. The analysis of organisational documents enabled the researcher to triangulate the data, and corroborate the data collected via other qualitative techniques. This contributed to the quality of data as issues that were not discussed by participants were explored through the organisational documents. The challenge experienced with the document analysis process was that some records were incomplete, and were inconsistent with what was reported in other documents. For example, in some cases food waste was inaccurately recorded. To overcome this, the researcher checked the consistency between different records that reported similar or complementary data. Additionally, the viewpoints of participants were sought in order to clarify records reported.

- *Face-to-face interviews*

Semi-structured face-to-face interviews were conducted with members of management at the case food service unit. A 100% response rate was achieved. This could be attributed to the fact that the interview setting was convenient and easily accessible to the participants as interviews were conducted at their offices (Bolderston, 2012). The approach enabled the researcher to gain detailed descriptions about food waste, quality management and sustainability practices at the food service operation, based on the participants' extensive experience at the University food service unit. Additionally, the interviews provided an insight to historical information that could not have been easily observed or gathered through alternative methods, given the short duration of the study. The approach was also beneficial as it enabled the researcher to clarify any questions to the interviewees, for example, clarity was needed on the questions concerning sustainability practices. The researcher was also able to seek clarification on aspects that were not clear. In this way, the quality of the data was improved and the ambiguity of the data was reduced. A conversational style and open-ended questioning, typical of this technique, enhanced a good rapport and further contributed to the depth and quality of the findings. However, a challenge was faced when conducting face-to-face interviews. Some of the participants were unwilling to share information about the extent of food waste experienced, and the causes of food waste generation. In such cases, the researcher reassured the participants about the anonymity and confidentiality of the information shared.

- *Focus group discussions*

The researcher conducted focus group discussions among food service employees at operational level. The use of focus group discussions was appropriate for this study as it allowed the researcher to gain multiple viewpoints or responses, which were used to further refine the constructs for the tool development. The technique allowed the researcher to generate complex information at a low cost in the shortest period of time. Another strength was that the comparisons that the participants made between one another's experiences and opinions, provided an insight about the complex practices contributing to food waste generation and its prevention. The focus group discussion guide was pilot tested and this led to the revision of the structure of the questions, rewording and deleting some questions, hence improving the validity of the instrument. The researcher further ensured homogeneity in grouping participants; they were grouped according to their roles in the food service unit. Separate focus group discussions for back-of-house and front-of-house workers were conducted. Staff members at management level were excluded from these focus groups. This avoided power dynamics that may have inhibited the discussions but promoted conversation and communication (Stewart & Shamdasani, 2015). The focus group discussions were conducted in a familiar territory - a function hall where the participants worked. As suggested by Kruger, Rodgers, Long and Lowy (2019) a suitable environment that is familiar to the participants is non-threatening and promotes conversation. For the focus group discussions, a horse-shoe seating arrangement was used and this maximised participant interaction and fostered discussion. Once the participants were seated, the researcher commenced by introducing herself, welcomed the participants and thanked them for agreeing to contribute to the focus group discussion. As suggested by Wong (2008), this was useful in building rapport and creating a sense of group cohesion. During the questioning stage, prompts and probes were used and this elicited conversation and encouraged participants to interact.

Some challenges were experienced during the focus groups. Active participants dominated the discussion, and passive ones did not express their opinions. To achieve participation from the passive participants, verbal intervention was applied, for example saying, ‘that is interesting, can we perhaps hear what others say?’. This was done tactfully, with encouragement and avoided the possibility of embarrassing the participants. The strategy proved to be beneficial, as at the end, all the participants engaged fully in the discussions.

- *Participant observation*

A fourth data collection technique; participant observation, was used. This technique was valuable as it complemented other qualitative data collection methods that were applied. The observation of participants’ actual practices, gave the researcher the opportunity to gain an in-depth understanding and clarity of issues raised during the face-to-face interviews and group discussions. As suggested by Creswell (2014), this technique was also useful in exploring the investigation areas, which the participants were uncomfortable to disclose, such as food waste generation as it occurred at the food service unit. The participant observation procedure therefore, enabled the researcher to gain new themes related to the area under investigation, which were silent or not shared by the participants during the interviews. The good relationship built between the researcher and the participants through rapport building sessions, by establishing cooperation and trust, contributed to the quality of the data. However, at some point during the observation process, the researcher was seen as an intruder and an outsider. Some questions like; ‘are you a spy on food waste?’ were posed to the researcher. To address this and reinforce trust and good relationships, the researcher held rapport-building sessions and assured participants of the confidentiality and anonymity of information.

8.3.2.3 Data analysis and interpretation

The data gathering exercise involved a simultaneous process of data collection and recording of field notes. Once the qualitative data collection process was completed, the data was entered and analysed electronically, using computer-assisted data analysis software – ATLAS.ti. This was beneficial as it allowed the researcher to transcribe and analyse data within a shorter period of time than it would have taken doing it manually. Not only was the use of the computer-assisted data analysis software time efficient, but it rendered the qualitative research credible as the processes followed, were transparent and replicable (Hwang, 2008).

The thematic analysis approach was used to systematically identify, analyse and record patterns or themes that emerged from the data. This approach was best suited for the study, as it enabled the researcher to identify emerging themes from the data, which contributed to the conceptualisation and development of the tool to address food waste in the University food service sector.

8.3.2.4 Quality of data

A number of measures were applied to improve the trustworthiness and quality of the data across four constructs: credibility, transferability, conformability and dependability. These are presented in the next section.

- *Credibility*

Credibility was ensured by having a prolonged engagement with participants at the research site. The data was collected over a period of five months; the process was stopped at a point when data saturation was reached. Methodological triangulation was achieved through the application of multiple data collection techniques. This was critical in establishing evidence, and it provided multiple perspectives that enriched the understanding of the research question. Not only did this add to triangulation but contributed to the collection of extensive data that addressed the holistic nature of the study. Throughout the data collection process, the findings and their interpretation were verified through respondent validation or member checking. This involved sharing preliminary findings with participants and providing them with the opportunity to comment on the findings. Participants identified areas where data was misinterpreted, and these were immediately corrected. At the end of the member checking exercise, participants confirmed that all findings were a true reflection of the information they had shared of their experiences.

- *Transferability*

A rich account of the setting, the sampling strategy, criteria for selecting participants, events and perspectives about the themes, excerpts from the interviews, and the research process were provided to enable the reader to assess whether or not the findings were transferrable to their own setting – transferability judgement. Purposive sampling also contributed to the transferability of the study, as this provided in-depth findings, since participants were particularly knowledgeable and experienced with food waste in the University food service system.

- *Confirmability*

Confirmability relates to the extent to which the findings of the study could be corroborated by other researchers and not based on the researcher's own bias (De Vos *et al*., 2011:421). Triangulation had a role in promoting conformability, since the corroboration of findings helped ensure that the findings shared, represented the experiences of the participants. In addition, the insights and perspectives of the participants were adequately represented in quotation marks as part of the presentation of findings. An audit trail, in the form of audio recordings, transcripts and field notes are available for scrutiny to ensure neutrality of the inquiry process and findings.

- *Dependability*

Dependability was established by triangulating the data collected. Additionally, a peer examination was conducted in which the researcher discussed the research process with other postgraduate students with experience in qualitative research. This contributed to the researcher's deeper reflexive analysis. In addition, the process helped with the identification of additional themes and negative cases.

8.3.3 Validation phase – modified Delphi technique

The modified Delphi technique was conducted to validate the tool developed to address food waste in the University food service. This was administered electronically using Qualtrics software. The use of this technique proved to be suitable for this study, since participants were not required to meet, this avoided problems inherent in face-to-face interactions, such as group conflict and individual dominance (Grisham, 2009; Morgan *et al*., 2016). The controlled feedback and anonymity characterised by the modified Delphi technique increased the reliability of consensus. The technique was beneficial as it validated the indicators of total quality management and sustainability practices that contributed to food waste prevention; an area which previously has not been documented in the context of food service units. Both purposive and snowball sampling were used to establish the Delphi panel. This was appropriate as it allowed the researcher to select participants working in the relevant field with substantial knowledge of the topic under investigation. The expertise and experience of the panellists contributed to the quality of the results. In total nine (9) experts completed the first run of the survey, and six (6) the second round.

Prior to administering the Delphi technique to the selected panel of experts, the questionnaire was pre-tested with a few selected practitioners. This led to the improvement of the survey tool, eliminated ambiguous and vague questions, and thus contributed to the reliability of the study. The study was limited to two rounds because a high level of consensus was reached after the second round. In addition, limiting the number of conducted iterations to two, decreased the risk of biased results that could occur because of participant fatigue and drop-outs (Gossler, Sigala, Wakolbinger & Buber, 2019). Thematic analysis was used to analyse the open-ended responses from round one. Quantitative data was analysed using SPSS, version 24 statistical analysis software. The level of consensus was measured using the level of agreement, standard deviation and interquartile range. To ensure the reliability of the study, conceptualisation, operationalisation and pilot testing were applied. To achieve validity, the items of the survey were assessed prior to data collection.

8.3.4 Ethical considerations

The ethical requirements were met throughout the study. Approval to commence with this study was obtained from the Ethics Committee of the Faculty of Natural and Agricultural Sciences at the University of Pretoria, which approved the research proposal before data collection started (see Addendum I); the researcher adhered strictly to the requirements. The researcher ensured protection of the participants from emotional and psychological harm through careful and sensitive phrasing of questions about food waste generation, so that the participants did not feel responsible nor guilty for food wasted. Participation was strictly voluntary, and the researcher emphasised that participants had the right to withdraw at any time. Signed, written consent letters were obtained from the participants. Privacy, confidentiality and anonymity were respected; the findings of the study were reported anonymously and the raw data was accessible only to the researchers involved in the study.

8.4 CONCLUSIONS DERIVED FROM THE MAIN FINDINGS

The overall aim of the study was to develop and validate a total quality management tool by integrating sustainability practices, to address food waste in the University food service units. The conclusion regarding the findings will be presented with regard to the objectives previously stated.

8.4.1 To investigate causes of food waste generation in the University food service system (Objective 1)

The development of a comprehensive and contextualised tool necessitated a holistic understanding of the causes of food waste at all levels of the food service system. To achieve this, the causes of food waste were investigated from a systems perspective, which was discussed in Chapter 2, Section 2.2. The interrelationships and interdependencies of the various factors contributing to food waste were explored. This is unlike previous studies, which failed to analyse the causes of food waste in the food service system holistically. This contributed to the literature in this regard.

As indicated in Chapter 5, Section 5.2, the input, activities in the functional subsystems, management functions, linking processes, output, control, memory and feedback had an influence on food waste.

8.4.1.1 Input

The findings indicated that inputs of the food service system that contributed to food waste were namely, human resources, materials, facilities and operational resources. The food service personnel's lack of professional skills and knowledge, which were linked to production errors, failure to produce good quality products, incorrect measuring of ingredients and misinterpretation of recipes, all contributed to food waste. This demonstrates the interdependency and interrelatedness of the food service system, as the inputs influenced food waste generation in the transformation subsystem (Chapter 5, Figure 5.3). Attitudes and habits of food service workers were raised as factors that influence food waste. Staff who had guilty feelings and fear of possible disciplinary action, did not record incidences of waste, and/or adjusted records of the food waste generated. In this way the memory element of the food service system was affected, as inaccurate records meant underestimating the level of food waste generated, hence failure to maintain a dynamic equilibrium. With regard to materials, the type and size of packaging for ingredients influenced food waste. The findings show that ingredients purchased in larger packages were sometimes left over, due to the unavailability of smaller sized packaging, and if not well managed, were wasted. In addition, the packaging of foods with a high viscosity were difficult to empty, which led to food waste. An important element that emerged in causing food waste, was the contribution of the supplier to the food service operation (Chapter 5, Figure 5.4).

The use of preprepared ingredients influenced food waste generation in varying degrees. Storage waste occurred in cases where customers did not buy ready-to-eat food items before they reached the expiry date. Service waste was created when customers rejected the pre-prepared food items, due to the perception of poor quality compared to freshly prepared ones. However, production waste was reduced, as little or no preparation meant no waste arising from such tasks as trimming, peeling, and production. Poor quality ingredients were also cited as a contributing factor to food waste at different stages of the functional subsystem. For instance, receiving poor quality ingredients caused food waste during storage, due to spoilage before the food item could be used. Additionally, using poor quality food ingredients led to the production of poor-quality menu items (production waste), which were often rejected by customers (service waste). This demonstrates that parts of the food service systems interact with one another but are also interdependent, with inputs (quality of ingredients) influencing food waste in other parts of the system.

The findings further revealed that the unavailability of appropriate or suitable equipment affected food waste. For instance, the unavailability of portioning frames at the University food service unit resulted in incorrect portioning, hence food waste generation. Under operational resources, strict operating times without consideration of the food remaining after service, was viewed as a constraint linked to food waste generation. Section 5.2.1.4 elaborates on how closing times influence food waste generation, an aspect that was mentioned in previous literature but not elucidated.

8.4.1.2 Transformation

Different factors in the functional subsystems of the food service operation, management functions and linking processes, caused food waste in the transformation process. The main findings on these aspects are presented below.

- *Functional subsystems*

The causes of food waste in the functional subsystems from purchasing to service at the University food service system were investigated. Purchasing unpopular food items that were not consumed before expiry, led to food waste. In addition, overstocking was identified as a contributing factor to food waste but to a lesser extent, as the use of a computerised stock management system, stock monitoring by recording stock movement and inactive food items, and flexible menu planning, alleviated the generation of food waste. This demonstrates the important role of the memory element in food waste management. At the point of receiving, failure to check the quality of ingredients against specifications and identify poor quality, damaged or spoiled food products at the time of delivery, led to receiving food that ended up being discarded instead of rejected and returned to the supplier. This was a noticeable issue with fresh produce. Failure to promptly transfer perishable food items from the receiving area to the storage areas, also contributed to food waste.

At the storage point, food items that were incorrectly stored, spoiled readily and deteriorated in quality. Additionally, failure to store food at the correct refrigerator and freezer temperatures led to their spoilage, making it unsafe for consumption. However, it was a rare occurrence that mechanical failure of the refrigerators and freezers led to food spoilage at the University food service unit. Moreover, failure to follow inventory and stock rotation methods, such as FIFO, led to food waste as the stock was used without consideration of the expiry dates, hence wastage of older stock. Failure to date mark food during storage was identified as a reason for food waste, as it made it difficult for food service workers to make decisions on which food products to use at a certain time, which led to deterioration of older stock, hence waste. While poor stock management has been cited as a cause of food waste in food service operations, failure to date mark food during storage has not been previously cited in the literature. This study therefore, contributes to the literature in this area. Furthermore, the findings showed that failure to control pests and insects in the storage areas contributed to food waste. This factor has not been previously documented in the food service literature but it is rather frequently mentioned in the primary agricultural production literature. The study further revealed that food waste occurred as a result of failure to weigh food, and inaccurately measuring ingredients during the process of issuing.

Under the production element, overproduction was frequently cited as one of the leading causes of food waste. The themes that emerged from the findings regarding food waste as a result of overproduction informed the development of the food waste framework presented in Chapter 5, Figure 5.12. This demonstrates the contribution of the study to the literature on food waste in food service operations. Overproduction of food led to food waste at the service and storage points, which indicated the interdependency nature of the food service system. Food production errors, such as overcooking food items as a result of improper temperature control, and the failure to adhere to prescribed cooking times, influenced the production of food waste. The current study clearly discussed overcooking as a contributor to food waste, an area that was overlooked in previous literature. The study further illustrated that food waste generation differs with the type of food production system used. The points where food waste was generated in the different food production systems are illustrated in Chapter 5, Figure 5.19. Other factors that caused food wastage, included incorrect measuring of ingredients during production, preparation tasks such as peeling, trimming and cutting, and discarding excess food during production, which was fit for consumption.

The findings further showed that forgetfulness by food service workers and the lack of communication about hot-held food caused food waste during hot-holding. From a systems perspective, this demonstrated the interrelations between hot-holding, inputs (human resources) and linking processes (communication) and their impact on food waste. Additionally, keeping food for too long in the heated cabinets led to overcooking of food and quality loss, hence food waste. Previous literature has not documented this factor and thus the study contributes to the literature in food waste. The study further indicated that holding more food than required, without consideration of the forecasted number of customers or the amount of food already produced, led to food wastage. Under the cook-chill and cook-freeze systems, food waste was experienced where chilled or frozen food lost quality before consumption. Examples of such cases are cited in Chapter 5, Section 5.2.2.1, under distribution and service. Food waste also occurred as a result of reheating food in bulk that ended up not being consumed during service and was discarded due to food safety requirements. Further to that, failure to adhere to the correct reheating procedures, including time and temperature controls, led to quality loss of food, hence wastage. Both the centralised and decentralised delivery service systems contributed to food waste. It was found that where the centralised system was used, customers rejected food, due to perceived poor food quality, which generated food waste. Poor portion control in this system also led to food waste. Where meals were produced at the central kitchen then distributed to remote sites (commissary food service system), the decentralised delivery-service system was used. In this system, food waste occurred, as a result of changes in the forecasted numbers of customers. The type of service style also had an influence on food waste generation. The buffet service contributed to food waste as a result of overproduction. With regard to the traditional cafeteria service style, food waste was generated where customers requested smaller portions, and the leftover food was not properly managed. It was further illustrated that inaccurate portioning, inconsistencies in the amount of food served and limited flexibility in portion size servings, contributed to food waste. In a few cases, errors, such as food spillages during service created food waste.

- *Management functions*

Generally, the findings of the study demonstrated that management functions contributed to food waste in the University food service system. Under the planning function, the goals and objectives, policies, procedures and methods had an influence on food waste generation. The goal of the University, which was to provide students with nutritionally, adequate meals, contributed to food waste, as it meant inclusion of food items (especially salads and vegetables) that were nutritional but not preferred by students. Strict food safety policies, as well as failure to adhere to food quality policies, contributed to food waste. In addition, failure to communicate the food waste management policy openly, created food waste as this led to some food service workers failing to effectively implement the policy. The lack of adherence to standard operating procedures (SOPs) also contributed to food waste generation as elaborated in Chapter 5, Section 5.2.2.2.1. It can be concluded that the controls when planning, were developed to ensure the safety and quality of food, contributed to food waste when inappropriately implemented, and when too rigid to accommodate changes to avoid wastage.

Under the organising function, it was shown that the division of work on a rotational basis, rather than based on specialised skills, contributed to food waste. This occurred when food service workers, who were assigned tasks without considering their skills, made production errors, which led to discarding the food. Another factor that contributed to food waste was the lack of staff members who were directly responsible for food waste management, hence workers at operational level did not feel accountable for food waste prevention. With regard to the staffing function, aspects such as recruitment and selection, training and development, had an influence on food waste generation. The recruitment and selection of untrained staff, with no prior experience in the food service sector, contributed to food waste because they were inclined to make mistakes during food production. The lack of in-service training exacerbated the food waste generation problem as food service workers, who were not trained, failed to perform some operational practices.

Under the directing function, the failure of management to give clear instructions, guide and supervise food service workers also had an influence on the creation of food waste. Inconsistencies by management in addressing staff members on food wastage, worsened the problem as some employees felt their efforts to prevent food waste were futile, while others were not reprimanded for wasting. In addition to this, the lack of routine monitoring of food waste, as well as the coordination of the day-to-day activities, aggravated the food waste issue. A considerable amount of waste was generated but not recorded. Further to that, regular inspections were conducted at the University food service unit but the food waste component was overlooked. As a result, records (memory element) did not reflect the true level of actual food waste generated, hence depriving management of the opportunity to devise appropriate corrective measures. Still under the reporting function, poor intradepartmental reporting or communication, interdepartmental communication, and communication between management and operational staff members contributed to food waste. Under the budgeting function, a restricted budget often meant purchasing lower-priced food products, which were not necessarily the best quality, and this compromised the quality of menu items produced, which were rejected by the consumers, hence food waste.

- *Linking processes*

The findings illustrated that the linking processes, i.e., communication, decision-making and balance, had an influence on food waste creation. As indicated above, ineffective communication across the different levels of food service workers contributed to food waste, since practices which contributed to food waste, remained unknown. The ineffective communication between the food service unit and customers implied the failure to understand and address customer needs, hence food waste due to the non-acceptance of food. The decision-making approach followed by the food service unit influenced the creation of food waste. Food waste resulted from the failure of top management to give lower management full authority to make programmed decisions concerning day-to-day activities. This meant the activities that generated waste were overlooked under the proposition that 'that's how management wanted things to be done'. The findings further indicated that creating a balance between food waste reduction, and food safety requirements, was difficult.

8.4.1.3 Controls

Internal and external controls used at the University food service system influenced food waste to varying degrees. The fixed menu for booked meals, which is an internal control, led to the wastage of vegetables and desserts, when customers chose not to take these at the point of service, yet these would have been prepared according to the fixed menu and the bookings. Contracts between the food service unit, suppliers, and the students caused food waste. It was revealed that failure to adhere to the food service unit-supplier contractual agreements led to the procurement of substandard ingredients, which affected the quality of menu items, hence waste. It was further demonstrated that meal plan contracts between the University food service unit and students, restricted the change of meal options, which led to the wastage of the dishes that were not selected by the students. The University was contractually bound to the agreed meal plans and could not make meal changes despite the waste. Failure to implement quality controls, contributed to food waste. This was elaborated on in Chapter 5, Section 5.2.3.3. These findings indicate that even though controls are in place to ensure the quality and safety of food, when they are too strict or not adhered to, they contribute to food waste.

8.4.1.4 Memory

A link was established between the memory element and food waste in the University food service system. Inaccurate forecasting based on past records of meal statistics and the booking system contributed to food waste, due to the unpredictable nature of the food service environment. The booking system exacerbated the issue as it allowed students to cancel their orders at a time when preparation was already done, while some decided not to collect the booked meals. The reasons for these were discussed in Chapter 5, Section 5.2.4. Inaccurate recording of leftovers was identified as a factor of food waste. This meant that the true picture of the actual quantity of leftovers and food waste remained unknown, hence an underestimation of the level of food waste generated. In turn, this limited the possibility to implement mitigation measures to address such waste. Planning and producing meals based on inventory records, created food waste as this led to overproduction of food items without consideration of the actual number of anticipated customers. The findings therefore, indicated the need to carefully analyse records and ensure accuracy in order to avoid food waste. This aspect can be related to the information and analysis component of TQM practices.

8.4.1.5 Outputs

The findings demonstrated that excess quantity of meals (overproduction) was a major cause of food waste. This has been highlighted in the previous sections. Poor quality meals, as a result of a combination of factors across the entire food service system, resulted in food waste. This further indicates the interrelatedness and interdependency of activities across the different stages of the system. Moreover, customer dissatisfaction, due to failure to meet quality expectations, resulted in less food purchased, hence service waste. Another factor, the lack of financial accountability by some food service workers who failed to realise the cost implications of waste, contributed to food waste. This was elaborated on in Chapter 5, Section 5.2.5.4.

8.4.1.6 Feedback

It was found that the ineffective implementation of the feedback mechanisms contributed to food waste. The University food service unit had a meal complaint system, which was continually used to obtain feedback from customers but customer complaints were not addressed. Failure to address customer complaints resulted in customers rejecting some menu items, which were eventually discarded. Additionally, food waste resulted from the failure to have feedback mechanisms between management and food service workers at the operational level. This deprived management of an opportunity to obtain information and complaints from staff that could have informed any strategies to mitigate food waste.

8.4.1.7 Environmental factors

Both the internal and external environmental factors influenced food waste generation. Food safety policies and regulations restricted the re-use of reheated leftover foods and food items exposed to the temperature danger zone and this resulted in food waste. The content and appeal of competitors' meal offerings also made it difficult to accurately forecast the number of food items to produce; where customers opted for competitors' meals, food waste resulted. It was further indicated that student demographics influenced food waste with more females than males generating food waste, as females tend to consume less food than males. The busy lifestyle of students missing meals was also associated with food waste generation, hence waste. Additionally, weather variations led to a fluctuating number of customers and difficulties in forecasting, hence the creation of a substantial amount of food waste.

Internal environmental factors, such as technical inefficiencies of cold storage equipment, led to food waste due to spoilage of the stored perishable food items. Unskilled food service workers, who lacked professional skills (input) were inclined to make production errors, which created food waste. University events, such as sports and academic assessment activities, were also linked to the difficulty of predicting the number of customers, which often led to overproduction of food, and then being discarded.

The next section concludes the main findings of the development of a total quality management tool, by integrating sustainability practices to address food waste in the University food service establishments.

8.4.2 To develop a total quality management tool, integrating sustainability practices to address food waste in the University food service system (Objective 2).

The following sub objectives addressed this primary objective:

- To investigate total quality management practices that contribute to the prevention of food waste in university food service units.
- To explore sustainability practices that prevent food waste in university food service units.

The conclusions in this section are therefore, structured according to these sub objectives.

8.4.2.1 Total quality management practices contributing to the prevention of food waste

The findings demonstrated the importance of the TQM approach as a **control** element contributing to food waste prevention. A total of eight dimensions of TQM were explored with regard to their potential to prevent food waste. These included quality practices of top management, customer focus, employee management and involvement, process quality management, employee knowledge and education, supplier quality management, information and analysis, and process and product quality design.

- *Quality practices of top management*

Quality practices of top management were of utmost importance in food waste prevention, since this was an enabler to successful implementation of quality management practices. Successful implementation of quality practices as a result of top management's commitment led to positive **outputs,** including waste reduction (Kim *et al*., 2012). The active participation of management in quality improvement efforts, such as on-site inspections, allowed management to develop corrective measures to address non-conformities thus improving quality and eliminating waste. In terms of the systems theory, this exemplifies the concept of **dynamic equilibrium**. Holding regular staff meetings where quality and food waste-related issues were discussed, played a role in food waste prevention. This facilitated communication (**linking processes**), and resulted in collaborative efforts to reduce food wastage. It was also evident that analysing and using data (**memory**) of food quality-related issues when making decisions (**linking processes**) prevented food waste. The analysis and interpretation of such data was useful in finding corrective measures to address food waste and quality deficiencies. Further to that, management provided human resources, materials, facilities and operational resources (**inputs**) necessary to enable quality improvement. In this way, good quality meals were produced (**output**), which resulted in the reduction of food waste, as no food items were discarded due to the failure to meet quality requirements and customer expectations. From the systems perspective, this illustrated the importance of the provision of **inputs** in supporting the TQM approach (**control**), thus supporting the production (**transformation**) of good quality meals, hence reduced food waste (**output**). Communicating food quality and safety policies, and standard operating procedures (**controls**) to food service workers through on-the-job training, meetings, use of notice boards, day-to-day verbal communication and giving instructions, reduced food waste. This improved the understanding, adherence and implementation of controls, hence the production of quality meals, which reduced the generation of food waste. Notwithstanding this, in some situations, strict safety regulations contributed to food waste generation. It was further indicated that giving employees the authority to manage food quality problems increased their responsibility to reduce food waste. This indicator is **interrelated** to the TQM dimension on employee management and involvement.

This study therefore, concludes that quality management practices of top management, which were considered a part of the management function, and as a control, is an important factor contributing to food waste prevention.

- *Customer focus*

Of note is the fact that this study viewed customer focus as an important part of the **feedback** element. This investigation indicated that feedback mechanisms that were in place to maintain communication (**linking processes**) between the food service unit and students, curbed food wastage, as this allowed the operation to understand consumer complaints, comments and suggestions, and to address them so as to avoid service and plate waste. This implies that the analysis of the given feedback enabled the University food service operators to better understand and respond to customer requirements, and to identify areas that needed improvement. Responding to customer complaints and addressing quality inadequacies, illustrated the food service unit's ability to maintain a **dynamic equilibrium**. This led to customer satisfaction (**output**), hence a reduction in service and plate waste (**output**).

- *Employee management and involvement*

The findings identified employee management and involvement as an important dimension in preventing food waste. Specifically, the findings suggest that the participation of workers in quality improvement activities reduced food waste. This is as a result of the involvement of workers being motivated to improve performance and commitment towards the provision of quality meals, hence waste reduction. The empowerment of food service workers to take initiatives prevented food waste, as this enabled workers to counteract food production errors before they occurred. Again, the recognition of superior quality performance by supervisory staff, and rewarding food service workers, who improved the quality, motivated them to continue doing so, hence food waste reduction. Recognised food service workers were positively associated with sharing expertise and guiding other workers to improve the quality; this had a bearing on quality performance and food waste reduction.

The findings illustrated that employee management and involvement can be viewed in two ways, namely as a component of TQM, and as a component of the **management function** of the transformation element. It can further be concluded that there is an interrelationship between employee management and involvement, linking processes (decision-making) and the outputs (employee satisfaction, meal-quality and food waste prevention).

- *Process quality management*

Process quality management emphasised a preventative and proactive approach to quality improvement that entailed detecting non-conformities, the determination of critical processes, areas and points for improvement. This led to the development of tools, processes and standards, which reduced product variation, improved quality performance and stabilised production; this resulted in increased product quality and reduced waste, as quality problems were identified and prevented or rectified immediately. The provision of comprehensive work instructions to employees, improved compliance to set-work procedures, hence reducing food wastage. This signifies the importance of clear communication and instructions to food service workers in maintaining quality and reducing waste. In addition, the formation of specific staff structures to support quality improvement led to the rectifying of the quality challenges, which reduced the production of poor-quality products, increased product output and thus contributed to the prevention of food waste. In conclusion, the implementation of process quality management practices influenced the output of the food service system, including meal-quality and food waste prevention. From the systems' perspective, the study implied the interrelatedness of process quality management to the element of **management functions**, **linking processes** (communication) and **feedback**.

- *Employee knowledge and education*

The findings indicated that employee training enhanced the workforce knowledge and skills, minimised production errors and reduced the need for the reproduction of faulty products, hence waste reduction. Additionally, training employees on quality management techniques, enriched the workers' knowledge and practice of quality management, which led to the production of good quality products thus curbing food waste. Employees' work experience in the food service environment was related to good quality food production and service, and food waste reduction. In conclusion, employee knowledge and education impacts on the level of skill (**input**) of the human resources' level of competency in performing activities in the functional subsystem of the food service operation, and the quality and quantity of meals (**output**).

- *Supplier quality management*

From the systems' perspective, supplier quality management was viewed as an external **control** element, as well as an **environmental factor**. Supplier quality management was shown to be an important factor in food waste prevention. The study showed that strict adherence to supplier-food service unit contractual agreements, such as set food specifications, enabled the food service unit to purchase good quality products, which was critical in producing quality menu items, hence preventing food waste. Chapter 6, Section 6.5.6, indicated how the adherence to food specifications prevented food waste. Suppliers' compliance to requested food expiry dates curbed food waste that could result from food spoilage during storage. However, where stock movement was not well managed, food waste due to the expiry of food products occurred. It was further identified that the provision of the right quantity of food products (**inputs**) ordered, lessened the chances of overstocking, hence waste reduction. Another factor; compliance with the transportation standards for food, as discussed in Chapter 6, Section 6.5.6, led to the procurement of good quality food products that did not spoil easily thus preventing food waste. Open communication (**linking processes**) between suppliers and the food service unit made it easy to arrange the replacement or substitution of ingredients to rectify complaints thus preventing food waste. Monitoring and the assessment of quality performance of suppliers, curbed food waste. The information obtained from the suppliers' evaluation served as **feedback** to the food service unit and was used for decision-making (**linking processes**). Additionally, suppliers used feedback from the evaluations for taking corrective measures (**balance**). This led to the improvement in quality performance by the suppliers, hence a reduction in food waste (**output**). This factor has not been documented in the literature previously thus the study contributes to the theory in this regard.

- *Information and analysis*

According to the framework developed in this study, information and analysis was viewed both as a **control** (TQM dimension) and a **memory,** as it dealt with the collection and analysis of information used in the food service system. Data collected used in the day-to-day operations of the University food service unit, were analysed (**feedback**) to make organisational decisions (**linking processes**), and to recommend corrective measures to address food waste and maintain a **dynamic equilibrium**. Examples of data collection tools used and analysed that contributed to food waste prevention were discussed in Chapter 6, Section 6.5.7.

- *Process and product quality design*

In this study, process and product quality design included activities carried out throughout the **functional subsystem (transformation)** of the food service system – from purchasing to service.

⇒ *Purchasing*

As discussed in Chapter 6, Section 6.5.8.1, the University food service unit applied a number of measures that prevented food waste at the point of purchasing. Accurate stock forecasting was an important factor in food waste prevention as it avoided overstocking. The use of an automated stock control system, stock movement and stock level records (**memory**) were beneficial to accurate forecasting. Similar to previous research (Charlebois *et al*., 2015; Heikkila *et al*., 2014), adherence to food specifications ensured that the food service unit obtained good quality food items, hence food waste prevention from possible spoilage or poor quality items. The study further identified the use of purchase orders as an important factor in food waste prevention, as this ensured that the right products were ordered and the correct quantities delivered, hence avoiding overstocking and stock mismatches. The food service unit requested the supply of perishable food with a sufficiently long shelf life; this helped prevent waste that could occur due to food spoilage. The selection of reputable suppliers ensured the procurement of quality food products, which enabled the production of good quality menu items, hence curbing food wastage. Having a wide option of suppliers also optimised the availability of food items in the quantity and quality as promised to the customer, hence customer satisfaction and food waste reduction (**outputs**). These factors have not been documented previously thus provide an important contribution to the literature.

⇒ *Receiving*

Similar to past research (Charlebois *et al*., 2015; Pirani & Arafat, 2014), the inspection of food deliveries prevented food waste, as this enabled food service workers to identify poor quality products immediately and reject those that failed to meet the requirements. The temperature of perishable food items was checked upon delivery, and if found to be at incorrect temperatures were rejected; this avoided wastage that could result from spoilage or microbial growth. Labelling food products upon delivery was identified as an important factor that assisted in inventory management, hence minimising food spoilage. Additionally, the prompt transfer of deliveries to the appropriate storage areas prevented food spoilage by maintaining the appropriate temperatures, hence waste reduction.

⇒ *Storage and inventory control*

Generally, good storage and inventory control practices were linked to food waste prevention. Adequate storage space and facilities or equipment (**inputs)** prevented food waste, as this maintained the quality of food and ensured the easy arrangement of food, which enhanced inventory management. Regular cleaning of storage spaces lessened the risk of food contamination and the introduction of pathogenic microbes in food, which preserved the quality and safety of food thus preventing food waste (**outputs**). Further to that, the regular maintenance of the premises to prevent the entry of pests, routine inspections for pests and the application of pest control methods where needed, prevented food waste from contamination and damage. Storing food items under the correct conditions, and separately from chemicals and cleaning agents, maintained the quality and safety of food. This indicates the importance of the correct storage and management of each of the material inputs in the food service system. It was further established that the continuous tracking and accurate recording (**memory**) of stock levels, helped with menu planning using food items available and stock forecasting, hence avoiding overstocking. The investigation also showed it was important to cover food during storage, to avoid the loss of aesthetical qualities, hence preventing food waste. This factor has not been discussed in previous literature; rather the emphasis was on covering food during service.

⇒ *Issuing*

The use of a requisition form with quantities of the ingredients requested, enabled effective stock monitoring, hence food waste prevention as only the required quantities for production were issued. Similar to past research (Filimonau *et al*., 2020), the study identified that by measuring ingredients before issuing, ensured that accurate quantities were provided thus avoiding food wastage, due to issuing excess ingredients than required. Where ingredients issued did not match the standardised recipes or requisition form, unused or excess ingredients were returned to the storage area. This illustrates the interdependency nature of the food service system.

⇒ *Production*

A number of strategies applied at the production stage of the food service system minimised food waste. This included, the use of a production schedule, which served as an important communication tool (**linking processes**) to the food production team, and facilitated the division of food production labour (**management function**). In this way instructions pertaining to food production were clear, thus reducing food wastage. This shows the interrelations between the **functional subsystem**, **inputs** (human resources) and **linking processes** (communication) and their impact on food waste prevention (**output**). Overproduction, which was the main cause of wastage at the production stage, was controlled through the accurate measurement of ingredients, which ensured the production of good quality food items in the right quantities (**output**). Good thawing practices (in the cold room) reduced spoilage, as the food did not pass through the temperature danger zone and the quality of food was preserved thus preventing food waste. The use of standardised recipes (**control**) also reduced waste, as it led to the production of good quality meals in the right and consistent quantities. Time and temperature control, checking and recording the internal temperatures throughout the production element ensured the safety of food, which was critical in food waste prevention. At the end of each production process, food was evaluated and this helped to determine the acceptability of the food products before the food was distributed to the customers. Where the acceptable level of food quality was not reached, the food was modified thus reducing the likelihood of food waste generation, due to poor quality. The information recorded during evaluation (**memory**), also served as a feedback mechanism that informed the food service operation about the quality of products, and if the predetermined standards were not frequently met, the recipe standardisation process was revisited (**control**).

⇒ *Distribution*

The appropriate time and temperature control during rethermalisation, positively impacted the quality and safety of food thus prevented food wastage. Additionally, reheating in small batches minimised the chances of discarding excess food that may be left over after service, as the food safety policy (**control**) did not allow re-use of reheated leftover food. The use of appropriate meal distribution equipment (**inputs**) with temperature controls played an important role in preventing food waste. Similarly, maintaining the proper temperature during hot- and cold-holding, ensured that the food was within the safe temperature range, prevented food spoilage and retained the quality of food, hence reducing chances of discarding food. These factors have not been related to food waste in previous literature thus the study contributed to the theory in this area. In a decentralised delivery-service system, the use of insulated cabinets (**inputs**), which maintained the appropriate temperature, and checking and recording the temperature of food throughout the distribution process, ensured the safety of the food served.

⇒ *Service*

At the service point, the intrinsic quality of the food was evaluated (**control**) upon receiving from the food production unit. This allowed the food service unit to rectify quality issues before service, hence minimising food waste that could have occurred as a result of the non-acceptance of the food by the customers due to the poor quality. Effective portion control strategies, including verification of portions upon receipt from the food production unit and the use of standardised portioning tools, increased the accuracy of portioning thus reducing food wastage. As discussed in Chapter 6, Section 6.5.8.7, despite the adoption of preventative portion controls, oversized serving portions and inconsistencies were observed thus generating wastage. This may suggest the need for intensified training and supervision of portion control. Furthermore, the monitoring and maintenance of the appropriate temperatures by using the appropriate equipment and regular checking, ensured that the food did not fall within the food temperature danger zone and that it was served at the correct temperature. Food was also kept covered in order to maintain its safety and aesthetic quality. This contributed to food waste prevention as both the quality and safety of the food were well maintained. Similar to previous findings (Betz *et al*., 2016; Ofei *et al*., 2014), attractive meal presentation attracted customers to purchase meals thus reducing the amount of food remaining at the service point. Furthermore, if leftovers from the service point were properly managed through chilling or freezing within controlled times, food spoilage was prevented and food waste reduced. The findings illustrated the interdependency of the service and production elements of the functional subsystem.

In conclusion, as illustrated in Figure 8.1 (next page), the implementation of total quality management practices has an influence on the outputs of the food service system, including food waste reduction.

The next section concludes on the main findings on sustainability practices that contributed to food waste prevention.

8.4.2.2 Sustainability practices contributing to food waste prevention

During the qualitative phase of the study, an investigation was made of the sustainable practices contributing to food waste prevention in the University food service operation. These were categorised into food-focused practices and environmentally focused sustainability practices. The study demonstrated the importance of food-focused practices in reducing food waste. From the input-output model of sustainability practices and food waste prevention developed in this study (Figure 7.9), it is indicated that seasonal and organic food (**inputs**) contributed to food waste prevention. This is attributed to their premium quality, which results in better customer acceptance (**output**) of menu items produced from these ingredients, hence less waste generated. As of practices in the transformation subsystem, following food safety and sanitation regulations curbs food waste that could occur due to the contamination of food. The sustainable practices led to reduced food waste and environmental sustainability (**outputs**). The consideration of sustainability in preventing food waste marks an important theoretical contribution of the study.

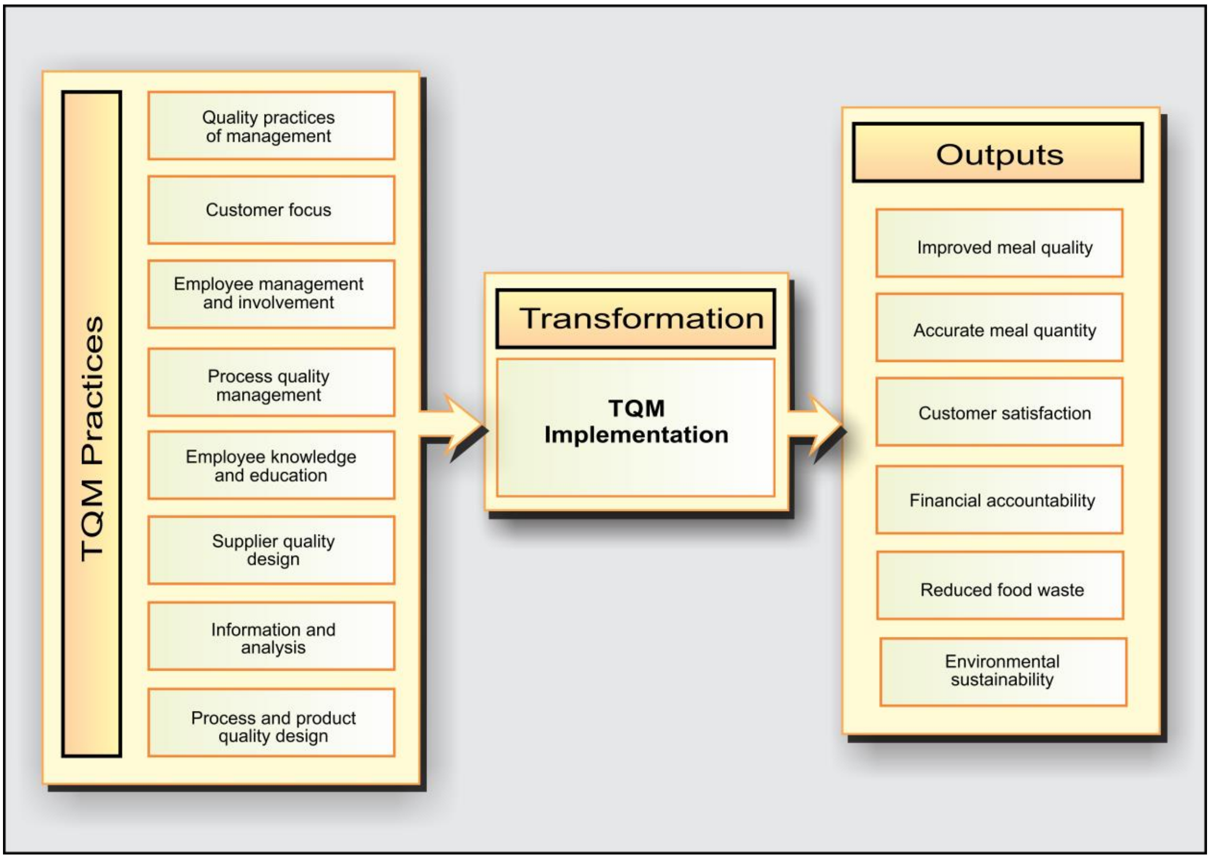


FIGURE 8.1: IMPACT OF TOTAL QUALITY MANAGEMENT PRACTICES ON THE OUTPUT OF THE FOOD SERVICE SYSTEM

8.4.3 The validated tool for addressing food waste in university food service units

The study further sought to validate the total quality management tool integrating sustainability practices, developed to address food waste in the university food service system. As illustrated in Chapter 7, Table 7.35 a total of eight dimensions and 114 indicators of total quality management practices were validated as important in food waste prevention. Under sustainability practices, only one (1) of the two (2) dimensions reached consensus (food focused sustainability practices) and five (5) indicators reached agreement on the importance of food waste prevention. This is an indication that some sustainability practices may reduce the negative environmental impact but not necessarily prevent food waste.

8.5 FINAL CONCEPTUAL FRAMEWORK FOR THE STUDY

Based on the main findings of the study, the final conceptual framework of the study was presented (Figure 8.2). This final framework serves as validation of the initial conceptual frameworks developed throughout the study (Figure 2.25 and Figure 3.13).

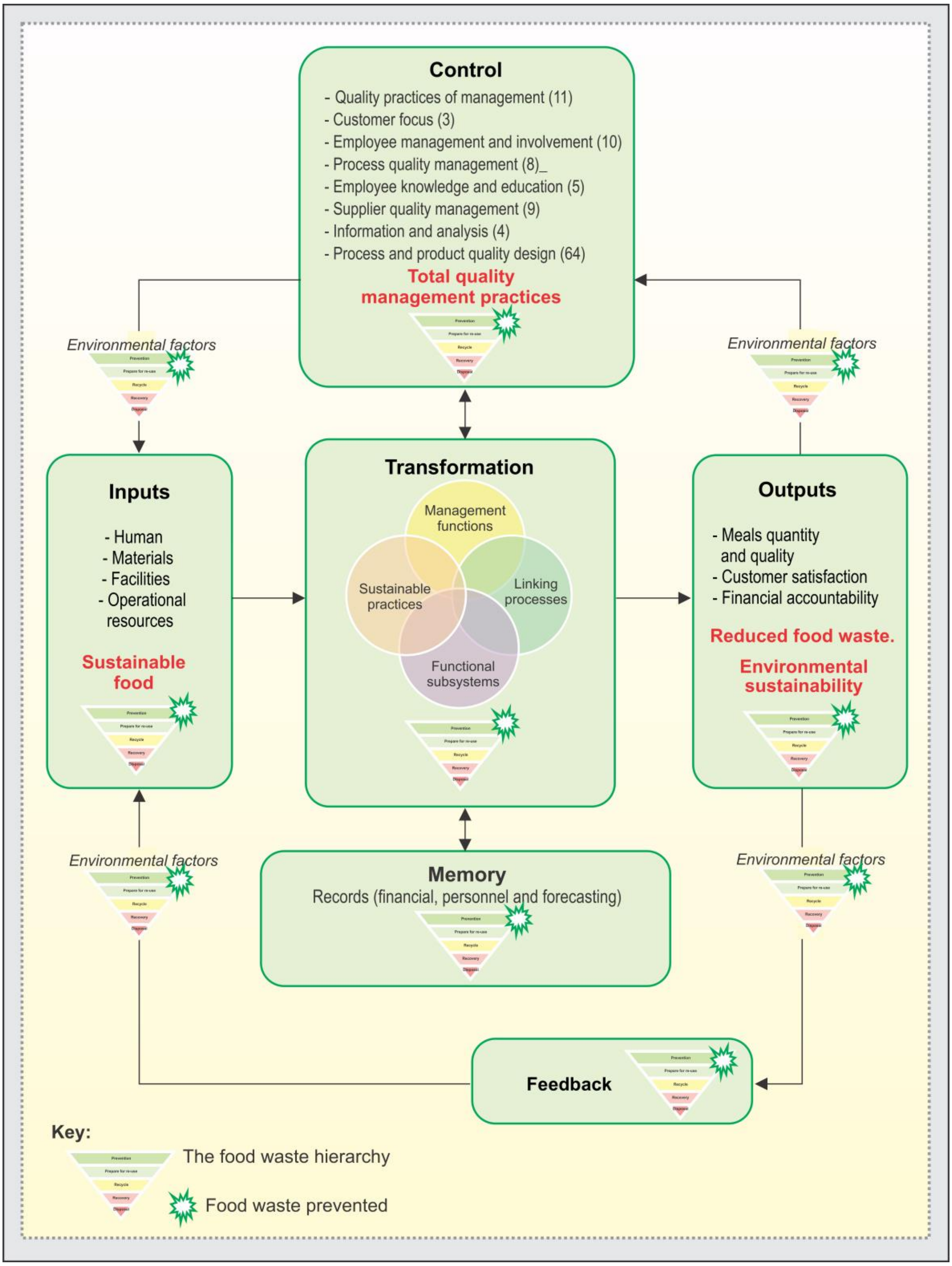


FIGURE 8.2: FINAL CONCEPTUAL FRAMEWORK OF THE STUDY

The final conceptual framework indicates that the inputs, including skilled and trained human resources, the availability of adequate and appropriate spatial facilities and equipment, good quality ingredients packaged in the required sizes and packaging material, as well as operational resources, including finances to purchase the required materials and equipment to support the production of good quality menu items, operational times, and information, all had an influence on food waste generation or its prevention. The study integrated sustainable inputs, namely seasonal food and organic food, which had the potential to prevent food waste in the food service system. This marks the contribution of the study to the literature. These inputs are transformed into outputs through the activities and processes in the transformation subsystem.

The elements of the transformation, including the management functions, the functional subsystems and linking processes, were considered instrumental in preventing food waste or being the cause of it, as discussed throughout the study. Sustainable practices, including following safety and sanitation requirements were integrated into the transformation subsystem. The study demonstrated that these prevented food waste and reduced environmental harm. The model further indicates the outputs that are important in any food service operation, including the desired quantity and quality of menu items, customer satisfaction, employee satisfaction and financial accountability (Gregoire, 2013:6). These outputs were directly related to food waste. Reduced food waste and environmental sustainability are important outputs introduced and integrated in this model. The control subsystem, which largely comprised of total quality management practices, played a role in food waste prevention. Still under the control element, contractual agreements between the University food service unit, the suppliers and the students (for meal plans), food quality and safety policies, standard operating procedures, and the goals and objectives of the food service operation, influenced food waste generation and its prevention in different ways. The memory or the University food service units' records, including inventory-, financial-, forecasting-, inspection reports, meal statistics and food waste records provided important information that enabled management to make adjustments to the food service system so as to curb food waste. Accurate recording was considered important in food waste prevention, while inaccurate recording contributed to wastage. Feedback mechanisms introduced to communicate and obtain feedback from customers and food service workers influenced food waste generation and prevention to varying degrees.

External and internal environmental factors, including food policies and regulations, competition, student demographics, students' lifestyle, weather, technological failures, unskilled staff and University events, influenced food waste, as discussed in Section 5.2.7. Responding to these environmental factors and maintaining a dynamic equilibrium contributed to food waste prevention. At each subsystem, consideration was given to practices that promoted the prevention of food waste over other options in the food waste hierarchy, as this was the most environmentally friendly alternative.

In the next section, theoretical and practical contributions of the study are discussed.

8.6 CONTRIBUTIONS OF THE STUDY

The study made valuable contributions to the literature in the investigated field, as well as practical implications for the University food service operations, as discussed in the next section.

8.6.1 Theoretical contributions

From the study, a new theoretical framework was developed, as well as contributing to research methodology and adding knowledge to the existing gaps of the different aspects of food waste in the University food service sector. These contributions are discussed in the section below.

8.6.1.1 Pioneering of a new hybrid theoretical framework

Addressing complex environmental problems, such as food waste and sustainability challenges in the food service field, requires academics to embrace new and innovative ways of thinking. Part of this process is the acceptance that not one discipline has all the answers, and the best possible outcomes are more likely to occur when researchers reach across disciplinary boundaries to amalgamate their specialised knowledge in an interdisciplinary nature. Chapter 2 of this study provided the theoretical backdrop for the framework, by introducing a hybrid model using frameworks from three disciplines: the systems model and its application in the food service sector; the food waste hierarchy as a framework for food waste management in food service operations with the emphasis on food waste prevention; as well as the triple bottom line framework with the focus on the environmental aspect, by looking into sustainable practices that cause less impact on the environment and reduce food waste. Following this, the models and approaches were combined and the new integrated sustainable-systems framework preventing food waste in the food service system, was developed. This framework is presented in Figure 8.2 above.

8.6.1.2 A holistic approach to understanding the causes of food waste and its prevention

The strategies to prevent food waste throughout the entire food service system is considered a challenging task, due to its complexity, the interdependencies of the parts of the system and the permeability of the boundaries of the food service system. The existing literature and tools to address food waste are limited in that they do not view the food service system holistically. This study introduced a holistic approach to understanding the causes of food waste and how to address this. The study considered how each subsystem contributed to food waste generation or its prevention, and/or how it influenced other subsystems to generate or prevent food waste. Systems analysis was applied to develop a holistic tool to address food waste at the different stages of the food service system. Food waste prevention strategies were adopted on the basis of their overall influence on food waste at the organisational level (on the system as a whole), the subsystem itself and interrelated subsystems. The study advocates that the first step towards a more sustainable resolution to the food waste issue is to adopt an approach that tackles food waste throughout the entire food service system.

8.6.1.3 Interdependency of subsystems and their contribution to food waste generation

Throughout the study, the interdependency of subsystems and their contribution to food waste generation were discussed in detail. Section 5.2.1.1 demonstrated the interdependency nature of the food service system and how the different parts affected each other and contributed to food waste. This interdependency is illustrated in Figure 5.3. Past research does not clearly show the interdependency of subsystems and how these contribute to food waste generation. This research contributes to the literature in this regard.

8.6.1.4 Overproduction and waste framework

The themes that emerged from the investigation regarding food waste caused by the overproduction of food, informed the development of the food waste framework discussed in Chapter 5, Section 5.2.2.1, and presented in Figure 5.12. The framework disentangles how overproduction of food causes food waste in the different stages of the food service system. It further indicates options adopted when dealing with food waste arising from overproduction, based on the waste hierarchy. The study is the first to interpret overproduction in the food service system in this manner thus contributing to the theory on food waste management.

8.6.1.5 Food waste generation at the supplier-food service interface

Another important theoretical contribution of the study is its illustration of food waste generation at the supplier-food service operation interface. For instance, the failure for a supplier to use appropriately-sized and easy-to-empty food packages led to food waste at the food service operation level. This is illustrated in Chapter 5, Figure 5.4. The study therefore, suggests that there is a need to consider the factors that give rise to food waste throughout the food supply chain, or the contribution of each stakeholder in the food supply chain on food wastage at each stage of the food system.

8.6.1.6 Application of TQM practices in food waste prevention

The review of the literature revealed that much attention has been devoted to examining the role or contribution of TQM practices on performance (Agus & Hassan, 2011; Kaynak, 2003; Sadikoglu & Olcay, 2014), innovation (Kim *et al*., 2012; Prajago & Sohal, 2003), and customer satisfaction (Mehra & Ranganathan, 2008; Kristianto *et al*., 2012; Topalović, 2015). Little attention has been given to examining the influence of TQM practices on waste prevention. The only study found was conducted in the health care setting where Askarian *et al*. (2010) indicated that TQM practices contributed to the reduction in medical waste in an Iranian hospital.

The current study is the first to investigate TQM practices that contribute to the prevention of food waste in the context of the University food service system. The findings showed that TQM practices played an important role in preventing food waste in the food service sector. This therefore, indicates that the study closed the research gap in this area and made a valuable contribution to the literature.

8.6.1.7 Integration of sustainability practices to prevent food waste

As discussed in Chapter 3, Section 3.5.2, the literature on sustainable food systems has largely focused on agricultural food production practices and rarely addressed sustainability in food service units and its potential impact on food waste. The limited literature available on sustainability in the context of food service operations has no clear focus on integrating sustainable practices in the food service system in a way that also leads to the reduction of food waste (Bloemhof *et al*., 2015; Dauner *et al.,* 2011; TRSA, 2014). The current study therefore, adds to the limited literature in this area and demonstrates the importance of the indicators of sustainability in food waste prevention in the food service context.

8.6.1.8 Contribution to the literature on food waste in the South African university food service context

The review of the literature showed that a few studies (Marais *et al*., 2017; Painter *et al*., 2016) have investigated the issue of food waste in the South African university food service context. Unlike these studies, the current study disentangled the complexity and diversity of the causes of food waste, and applied a holistic approach in developing a tool to address the food waste issue. The study therefore, makes a significant contribution to the limited literature in this context.

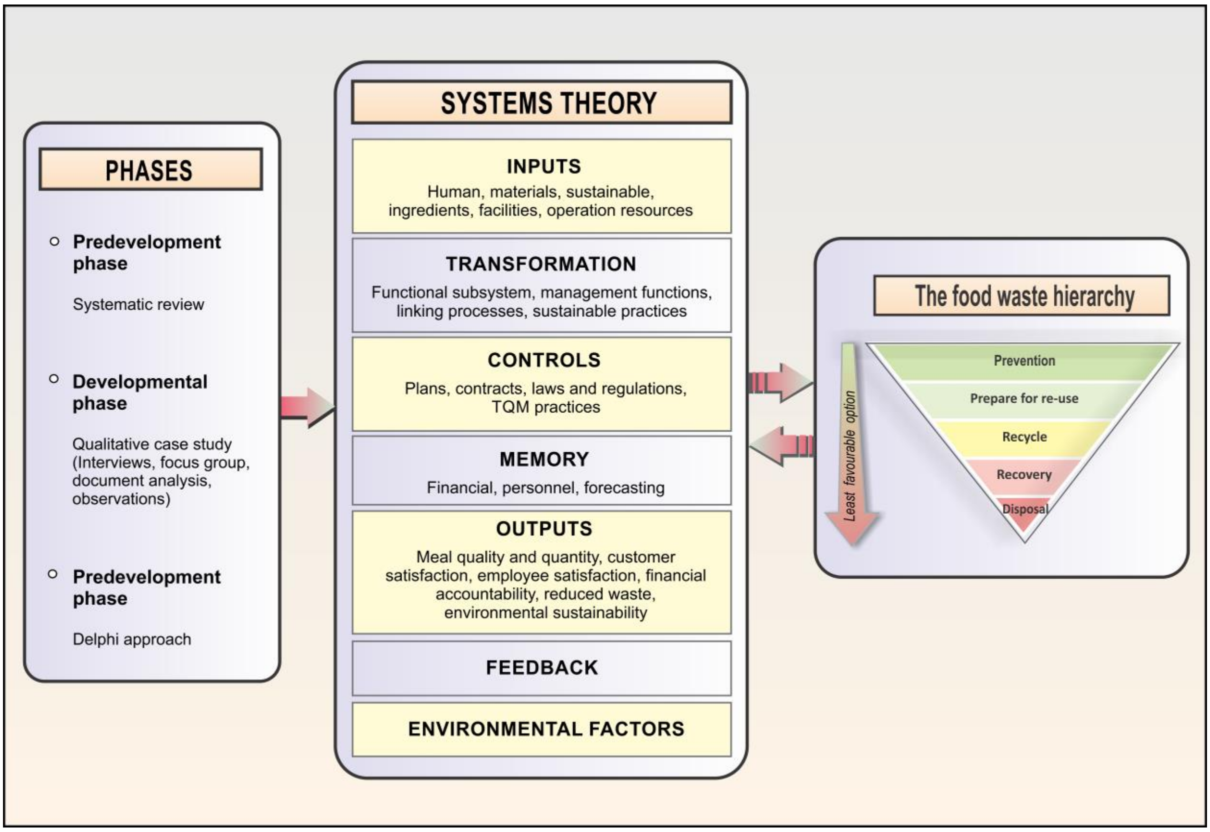
In the next section, methodological contributions of the study are drawn and discussed.

8.6.2 Methodological contributions

This work presents an adapted methodology based on a multiphase mixed methods design. Different techniques were used to collect data at each of the three phases of the tool-development process (systematic review, qualitative case study and Delphi method), with a view to harmonising their potentialities and reducing their limitations. This methodological approach is illustrated in Figure 4.1 and discussed throughout Chapter 4. The tool development process is identical to that described by Faul and Hudson (1999) in terms of the phases followed (predevelopment, developmental and validation phase), but differs in the methodological procedures followed at each phase. Some authors describe certain elements in the process only, for example, item generation, theoretical analysis, and psychometric analysis (Morgado, Meireles, Neres, Amard & Ferreira, 2017). Other scholars (Alyami, Rezgui & Kwan, 2013; Chami, Gavazzi, De Wazières, Lejeune, Carrat, Piette & Rothan-Tondeur, 2011; Chang *et al*., 2010; De Boeck, Jacxsens, Bollaerts & Vlerick, 2015; Wang *et al*., 2013) who developed and validated tools, only used the Delphi technique. The methodological approach followed in this study, to develop a tool to address food waste, may be useful for other studies where the intention is to develop tools in disciplines where the research of concepts is investigated but remain immature.

Another methodological contribution of the research has been the combination and application of concepts from the systems theory, waste management and sustainability approaches to structure the data collection and analysis process (Figure 8.3). A range of data collection techniques was used to explore each individual component of the systems model. Within each of these components, the researcher applied the food waste hierarchy framework to investigate practices that contributed to the ‘prevention’ of food waste. Sustainable inputs and practices were also considered in so far as they prevented food waste and contributed to environmental sustainability.

The next section discusses the practical contributions of the study and the implications of the findings for the University food service operations.



FIURE 8.3: THE SUSTAINABLE-SYSTEMS FRAMEWORK AS APPLIED TO STRUCTURE THE DATA COLLECTION AND ANALYSIS PROCESS

8.6.3 Practical implications

Based on the findings of the study, a number of strategies can be applied to prevent food waste in the University food service outlets. This part of the study suggests the practical implications for the University food service operations, looking at the reasons for food waste as discussed in Chapter 5, as well as the strategies to prevent food waste, which were discussed in Chapters 6 and 7 and outlined in the tool developed to address food waste.

8.6.3.1 Implementation of the tool developed to address food waste

An important contribution of the study was the development of a total quality management tool, integrating sustainability practices to prevent food waste in the University food service sector. The tool can be applied in the different areas of the food service system to prevent food waste. Moreover, food service operators would find the suggested strategies, which predominantly include TQM practices, helpful in their efforts to optimise quality performance in the different areas of the food service system, hence ensuring high quality products and services.

8.6.3.2 Food waste audits

The study demonstrated the importance of the availability of systems for tracking food waste and surplus. Reporting waste may provide management with an opportunity to develop mitigation measures to prevent food waste. Without a system for tracking food waste and surplus, a true picture of the actual level of food waste generated may remain unknown, and without any mitigation measures being developed. It is therefore, recommended that food service operators audit food waste to be able to apply specific strategies that target the factors leading to the generation of food in their operations.

8.6.3.3 Training and monitoring employees

The results of the study indicated the importance of employees' knowledge and know-how related to food service in addressing food waste. The professional competence of kitchen staff was related to improved quality performance and good practices around food waste prevention. Specifically, the results demonstrated the importance of orientation and the induction of new staff, quality-orientated training, food waste management, as well as training of all control measures to minimise waste. This therefore, implies that these are the important elements to consider in so far as staff training is concerned.

8.6.3.4 Supplier quality management

Based on the findings, supplier quality management is important in preventing food waste. Adherence to food specifications, compliance with food safety and quality measures by suppliers, assessment of supplier quality performance and timely delivery of supplies were factors identified as important in preventing food waste. Food service operations need to therefore, apply these practices in order to minimise food waste.

8.6.3.5 Reduction of the environmental impact of food waste

The tool developed to address food waste in this study, adopted food waste prevention strategies based on the most preferable option of the food waste hierarchy. These prevention strategies benefit the environment and are the most sustainable. The application of the developed tool may, therefore, reduce the negative environmental impacts associated with food waste, including greenhouse gas emissions, which contribute to global warming, as well as reduce the waste of water and energy.

8.6.3.6 Contribution to the attainment of the Sustainable Development Goals

The application of the food waste prevention strategies, as suggested from this study, may contribute to the attainment of the Sustainable Development Goals, which were approved in

2015 by the United Nations General Assembly. It is intended that these be achieved by the year 2030. Specifically, the study directly addressed SDG 2 and SDG 12. The Sustainable Development Goal 2 seeks to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture by 2030 (United Nations, 2019). The reduction of food waste at the University food service operations level, may ensure food security in the immediate University setting. Sustainable Development Goal 12: target 12.3, which aims to halve per capita global food waste at the retail and consumer levels by 2030, will be addressed as an application of the prevention strategies, which will contribute towards lowering the total amount of food wasted.

Table 8.1 below summarises the contributions of the study.

TABLE 8.1: SUMMARY OF THE CONTRIBUTIONS OF THE STUDY

Theoretical contributions	• The models and approaches (systems model, food waste hierarchy and triple bottom line approach) were combined and the adapted integrated sustainable-systems framework preventing food waste in the food service system, was developed. • The study introduced a holistic approach to understanding the causes of food waste and how to address this. • Illustration of the interdependency of subsystems and their contribution to food waste generation. • Development of the food overproduction and waste framework in the context of university food service units. • Illustration of food waste generation at the supplier-food service operation interface. • The study is the first to show the contribution of TQM practices and sustainability practices in food waste prevention in the context of university food service units. • Contribution to the limited literature on food waste in the South African university food service context.
Methodological contributions	• An adapted methodology based on a multiphase mixed methods design was applied. • The combination and application of concepts from the systems theory, waste management and sustainability approaches to structure the data collection and analysis process contributes to methodological approaches.
Practical contributions	• The tool developed can be applied in the different areas of the food service system to prevent food waste. • Food waste tracking is important in preventing food waste therefore food service operators should conduct food waste audits. • Training and monitoring of food service personnel is illustrated to improve quality performance and good practices around food waste prevention. • Supplier quality management is important in preventing food waste therefore strategies to manage this element should be applied. • The application of the developed tool may, therefore, reduce the negative environmental impacts associated with food waste. • The application of the food waste prevention strategies, as suggested from this study, may contribute to the attainment of the Sustainable Development Goals (SDG 2 and SDG 12).

Despite the important contributions of the study, it had its own limitations. The next part of the study discusses the limitations of the study.

8.7 LIMITATIONS OF THE STUDY

This research had its limitations, which present opportunities for future research. The next section discusses the limitations.

8.7.1 Sample size limitation

First, the study was limited to food service experts in only 26 South African public universities. The low response rate and thus a small sample size in the Delphi process was a limitation; this may have been due to the multiple feedback processes inherent and integral to the concept and the use of the Delphi process. Efforts were made to recruit panellists and to remind those who had partially completed the survey to do so but this was done with caution not to impede on the ethics. Notwithstanding this, concerning the appropriate number of subjects to involve in a Delphi study, from the research (Hsu & Sandford, 2007; Musa *et al*., 2015; Thangaratinam & Redman, 2005) it is recommended that researchers should use the minimal sufficient number of subjects. A sample size of four (4) and above is viewed as sufficient. The sample size in this study was viewed as a limitation as it increased the margin of error. It also decreased the statistical power of the application of the standard deviation and interquartile range in the second round of the Delphi thus only the percentage level of agreement was used. Other statistical measures, such as the Mann–Whitney U test, and Kolmogorov–Smirnov test, which measure the degree of consistency and verify potential bias in the answers, could not be applied due to the small sample size (Sossa, Hala & Zarta, 2019).

8.7.2 Methodological limitation

According to Chang *et al*. (2010) commencing the Delphi technique with dimensions and indicators already identified from the first two phases, may be viewed as a limitation as panel members can feel constrained in their responses and comments. Although panel members were given space for comments, in an attempt to overcome this constraint, few comments and suggestions were made. However, this may be an indication that the tool developed was sufficiently comprehensive, which lessened their consideration of additional indicators.

8.7.3 Item limitations

The rejection of some indicators of the sustainability practices may to some extent, reflect some potential item limitations. Some indicators were ambiguous, had inductors or alternatives, which might have caused confusion among panellists. For example, the term batch cooking can be interpreted as producing food in a large quantity all at once, then storing it in portions for later use or as cooking smaller quantities of menu items as required for service. Further studies, therefore, need to ensure that indicators are clearly defined in the context of the problem being addressed; these must express a single idea, and use the common terminology in the context of the study.

8.7.4 Generalisability

The second phase of the study applied a qualitative case study approach focusing on one South African university food service operation, therefore, generalisability is limited and the findings may not apply in other food service operations. Therefore, caution should be taken when applying these results to other food service operations.

8.7.5 Resource limitations

Conducting the Delphi study was time consuming. The Delphi survey instrument consisted of a large number of statements, which required subjects to dedicate large blocks of time to complete the questionnaire. The two Delphi surveys ran over a period of ten (10) months, with the first run administered in June 2018, and the second run administered in April 2019, and this potentially affected the response rate.

In addition to this, the study could not test the developed tool in practice and could not go further into the fourth phase of the tool development process; utilisation phase due to the financial and time constraints. According to De Vos *et al*. (2011: 220) the utilisation phase involves the formulation of a technical manual that describes the newly developed tool for further utilisation. It is therefore, recommended that future research consider empirically testing the reliability and validity of the tool in practice, and develop an implementation manual for this purpose.

The next section gives recommendations for future research.

8.8 RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the findings of the study, and the limitations, future research can be directed to the following:

- Even though the sample size of the study allowed establishing the consensus on the importance of indicators in preventing food waste, it would be particularly interesting to undertake the Delphi technique with a larger sample size, so as to use other statistical measures such as the Mann–Whitney U test, and Kolmogorov–Smirnov test, which measure the degree of consistency and stability (Sossa *et al*., 2019). In this way the validity of the findings will be enhanced.

- As discussed in Section 8.7.3, the results of this study must be interpreted in accordance with the generalisability limitations that were faced. It is for this reason that the recommendations for future research include the collection of data from a significant sample of diverse food service operators for the purpose of applying the findings in different types of food service operations.

- It is further recommended that future researchers consider extending the study to the fourth phase of the tool development (utilisation phase), empirically test the reliability and validity of the tool in practice. It is further suggested that an implementation manual be developed for use in the food service sector.

8.9 CONCLUDING REMARKS

The conclusions based on the findings of the study were presented in this chapter. The study developed and validated a total quality management tool to address food waste in the University food service system. The tool was developed and validated using a three phased mixed methodology, as discussed in Chapter 4. The study investigated causes of food waste from a systems perspective, considering factors that led to food waste generation at each stage of the food service system (Objective 1). In line with the most preferable food waste management option of the food waste hierarchy; that is prevention, the study explored total quality management practices (Objective 2.1) and sustainability practices (Objective 2.1) that contributed to the prevention of food waste. The developed tool was validated using a Delphi technique. This resulted in a tool with eight (8) dimensions and 114 indicators of total quality management practices, and one dimension and five (5) indicators of sustainability practices validated as important in preventing food waste (Objective 3). The study made important contributions methodologically, theoretically and practically as discussed in Section 8.7.

REFERENCES

Aamir, M., Ahmad, H., Javaid, Q. & Hasan, S.M. 2018. Waste not, want not: a case study on food waste in restaurants of Lahore, Pakistan. *Journal of Food Products Marketing*, 24(5):591-610.

Abeliotis, K., Lasaridi, K. & Chroni, C. 2014. Attitudes and behaviour of Greek households regarding food waste prevention. *Waste Management & Research*, 32(3):237-240.

Accorsi, R., Cholette, S., Manzini, R. & Tufano, A. 2018. A hierarchical data architecture for sustainable food supply chain management and planning. *Journal of Cleaner Production*, 203:1039-1054.

Adams, K.M. 2012. Systems theory: a formal construct for understanding systems. *International Journal of System of Systems Engineering*, 3(3-4):209-224.

Adams, K.M., Hester, P.T. & Bradley, J.M. 2013. *A historical perspective of systems theory*. In Proceedings of the 2013 Industrial and Systems Engineering Research Conference, 4102-4109.

Agus, A. & Hassan, Z. 2011. Enhancing production performance and customer performance through total quality management (TQM): strategies for competitive advantage. *Procedia Social and Behavioural Sciences*, 24:1650–1662.

Agus, A. 2001. A linear structural modelling of total quality management practices in manufacturing companies in Malaysia. *Total Quality Management*, 125:561-573.

Ahmed, M., Jones, E., Redmond, E., Hewedi, M., Wingert, A. & Gad El Rab, M. 2015. Food production and service in UK hospitals. *International Journal of Health Care Quality Assurance,* 28(1):40-54.

Akaichi, F. & Revoredo-Giha, C. 2016. Consumers demand for products with animal welfare attributes: Evidence from homescan data for Scotland. *British Food Journal*, 1187:1682-1711.

Akkerman, R., Farahani, P. & Grunow, M. 2010. Quality, safety and sustainability in food distribution: a review of quantitative operations management approaches and challenges*. Or Spectrum*, 32(4):863-904.

Alcorn, M.R., Vega, D., Irvin, R. & Paez, P. 2020. Reducing food waste: an exploration of a campus restaurant. *British Food Journal*, 123(4):1546-1559.

Al-Ababneh, M. & Lockwood, A. 2012. *Implementing total quality management in the hotel industry.* Paper presented at the 2nd Advances in Hospitality and Tourism Marketing and Management Conference, Corfu Island, 24 June:1-7.

Al-Kandari, D., Al-abdeen, J. & Sidhu, J. 2019. Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, 103:103-110.

Alsaffar, A.A. 2016. Sustainable diets: The interaction between food industry, nutrition, health and the environment. *Food Science and Technology International*, *22*2:102-111.

Alshehri, S.A., Rezgui, Y. & Li, H. 2015. Disaster community resilience assessment method: a consensus-based Delphi and AHP approach. *Natural Hazards*, 78(1):395-416.
Alyami, S.H., Rezgui, Y. & Kwan, A. 2013. Developing sustainable building assessment scheme for Saudi Arabia: Delphi consultation approach. *Renewable and Sustainable Energy Reviews*, 27:43-54.

Amissah, A.A., Mensah, J.V. & Antwi, K.B. 2015. Role Performance and Challenges of Male Single-Parent Families in the Central Region of Ghana. *Advances in Social Sciences Research Journal*, 2(11).

Anderson, M. & Sohal, A.S. 1999. A study of the relationship between quality management practices and performance in small businesses. *International Journal of Quality & Reliability Management*, 16(9):859-877.

Anil, A.P. & Satish, K.P. 2016. Investigating the relationship between TQM practices and firm's performance: A conceptual framework for Indian organizations. *Procedia Technology*, 24:554-561.

Anney, V.N. 2015. Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies*, 5(2):272-281.

Aquilani, B., Silvestri, C., Ruggieri, A. & Gatti, C. 2017. A systematic literature review on total quality management critical success factors and the identification of new avenues of research. *The TQM Journal*, *29*(1):184-213.

Askarian, M., Heidarpoor, P. & Assadian, O. 2010. A total quality management approach to healthcare waste management in Namazi Hospital, Iran. *Waste Management*, 3011:2321-2326.

Assaf, A., Matawie, K.M. & Blackman, D. 2008. Operational performance of health care foodservice systems. *International Journal of Contemporary Hospitality Management*, 202:215-227.

Atia, M.A. & Abdelgawad, A.R. 2016. Receiving and Storing Foods: The Procedures Followed in the Central Restaurants at University Dormitories. *Minia Journal of Tourism and Hospitality Research*, 1(2):1-26.

Babbie, E. 2016. *The practice of social research*. 14th ed. Boston, MA: Cengage Learning.

Babich, R. & Smith, S. 2010. 'Cradle to grave': an analysis of sustainable food systems in a university setting. *Journal of Culinary Science & Technology*, 8(4):180-190.

Baldwin, C., Wilberforce, N. & Kapur, A. 2011. Restaurant and food service life cycle assessment and development of a sustainability standard. *The International Journal of Life Cycle Assessment*, 16(1):40-49.

Black, S.A. & Porter, L.J. 1996. Identification of the critical factors of TQM. *Decision Sciences*, 27(1):1-21.

Beardsell, M.L. & Dale, B.G. 1999. The relevance of total quality management in the food supply and distribution industry: a study. *British Food Journal*, 1013:190-201.

Beer, S. 1972. *Brain of the Firm: the Managerial Cybernetics of Organisation*. London, UK: Allen Lane the Penguin Press.
Behara, R.S. & Gundersen, D.E. 2001. Analysis of quality management practices in services. *International Journal of Quality & Reliability Management*, 18(6):584-603.

Benbrook, C., Zhao, X., Yáñez, J., Davies, N. & Andrews, P. 2008. New evidence confirms the nutritional superiority of plant-based organic foods. The Organic Center. [Online] Available from: www.organiccenter.org.

Béné, C., Oosterveer, P., Lamotte, L., Brouwer, I.D., De Haan, S., Prager, S.D. & Khoury, C.K. 2019. When food systems meet sustainability — Current narratives and implications for actions. *World Development*, 113:116-130.

Benson, P.G., Saraph, J.V. & Schroeder, R.G. 1991. The effects of organizational context on quality management: an empirical investigation. *Management Science*, *37*(9):1107-1124.

Bentley, M., Kerr, R. & Powell, S. 2016. The use of a modified Delphi technique to inform the development of best practice in interprofessional training for collaborative primary healthcare. *Journal of Research in Interprofessional Practice and Education*, 6(1).

Beraldin, A.R., Danese, P. & Romano, P. 2020. Employee involvement for continuous improvement and production repetitiveness: a contingency perspective for achieving organisational outcomes. *Production Planning & Control*, 1-17.

Beretta, C. & Hellweg, S. 2019. Potential environmental benefits from food waste prevention in the food service sector. *Resources, Conservation and Recycling*, 147:169-178.

Beretta, C., Stoessel, F., Baier, U. & Hellweg, S. 2013. Quantifying food losses and the potential for reduction in Switzerland. *Waste Management*, *33*3:764-773.

Betz, A., Buchli, J., Göbel, C. & Müller, C. 2015. Food waste in the Swiss food service industry – Magnitude and potential for reduction. *Waste Management*, 35:218-226.

Beverland, M.B. 2014. Sustainable eating: mainstreaming plant-based diets in developed economies. *Journal of Macro-marketing*, 343:369-382.

Bharucha, J. 2018. Tackling the challenges of reducing and managing food waste in Mumbai restaurants. *British Food Journal*, 120(3):639-649.

Bilska, B., Tomaszewska, M. & Kołożyn-Krajewska, D. 2020. Managing the risk of food waste in food service establishments. *Sustainability*, 12(5):2050-2068.

Bloemhof, J.M., Van der Vorst, J.G., Bastl, M. & Allaoui, H. 2015. Sustainability assessment of food chain logistics. *International Journal of Logistics Research and Applications*, 18(2):101-117.

Blokhuis, H.J., Jones, R.B., Geers, R., Miele, M. & Veissier, I. 2003. Measuring and monitoring animal welfare: transparency in the food product quality chain. *Animal Welfare*, 124:445-456.

Boddy, C.R. 2016. Sample size for qualitative research. *Qualitative Market Research: An International Journal*, 19(4):426-432.

Bohdanowicz, P. 2006. *Responsible resource management in hotels: attitudes, indicators, tools and strategies*. Unpublished doctoral dissertation. Stockholm: KTH Royal Institute of Technology). [Online] Available from: http://www.diva-portal.org/smash/get/diva2:10873/FULLTEXT01.pdfPaulina [Accessed: 2017-05-20].

Bolderston, A. 2012. Conducting a research interview. *Journal of Medical Imaging and Radiation Sciences*, 43(1):66-76.

Boley, B.B. & Uysal, M. 2013. Competitive synergy through practicing triple bottom line sustainability: Evidence from three hospitality case studies. *Tourism and Hospitality Research*, 13(4):226-238.

Bond, M., Meacham, T., Bhunnoo, R. & Benton, T. 2013. *Food waste within global food systems*. [Online] Available from https://pdfs.semanticscholar.org/6c91/c4a4bd7b73d2e51344f5fa8117532f80ceec.pdf [Accessed: 2016-08-07].

Bou, J.C. & Beltrán, I. 2005. Total quality management, high-commitment human resource strategy and firm performance: an empirical study. *Total Quality Management & Business Excellence*, 16(1):71-86.

Boulding, K.E. 1956. General systems theory — the skeleton of science. *Management Science*, 2(3):197-208.

Bouranta, N., Psomas, E.L. & Pantouvakis, A. 2017. Identifying the critical determinants of TQM and their impact on company performance: Evidence from the hotel industry of Greece. *The TQM Journal*, 291:147-166.

Bowen, G.A. 2009. Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2):27-40.

Braun, V. & Clarke, V. 2012. Thematic analysis. In Cooper, H., Camic, P. M., Long, D.L., Panter, A.T., Rindskopf, D. & Sher, K.J. (eds.) *APA Handbook of Research Methods in Psychology, Vol. 2. Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological.* Washington, DC: American Psychological Association.

Braun, V. & Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3(2):77-101.

Breen, R.L. 2006. A practical guide to focus-group research. *Journal of Geography in Higher Education*, 30(3):463-475.

Brink, H., Van der Walt, C. & Van Rensburg, G. 2006. *Fundamentals of research methodology for health care professionals*. Cape Town, SA: Juta and Company Ltd.

Broughton, A. 2020. Livestock and ecology. *Green Left Weekly*, (1257):12.

Brown, T., Hipps, N.A., Easteal, S., Parry, A. & Evans, J.A. 2014. Reducing domestic food waste by lowering home refrigerator temperatures. *International Journal of Refrigeration*, 40: 246-253.

Brunori, G., Galli, F., Barjolle, D., Van Broekhuizen, R., Colombo, L., Giampietro, M. & De Roest, K. 2016. Are local food chains more sustainable than global food chains? Considerations for assessment. *Sustainability*, 85:449.

Bryman, A. & Bell, A. 2011. *Research methodology: business and management contexts*. Oxford, UK: Oxford University Press.

Bryman, A. 2012. *Social research methods*. 4th ed. New York, NY: Oxford University Press.

Bryman, A. 2013. *Doing research in organizations*. New York, NY: Routledge.

Buckley, W. 1967. *Sociology and modern systems theory. Oxford, UK: Prentice-Hall.*

Burton, K., Serrano, E., Cox, H., Budowle, R. & Dulys-Nusbaum, E. 2016. Benefits, barriers, and challenges to university-level food waste tracking. *Journal of Hunger & Environmental Nutrition*, 11(3):428-438.

Buzby, J.C. & Hyman, J. 2012. Total and per capita value of food loss in the United States. *Food Policy*, 375:561-570.

Caldera, H.T.S., Desha, C. & Dawes, L. 2017. Exploring the role of lean thinking in sustainable business practice: A systematic literature review. *Journal of Cleaner Production*, 167:1546-1565.

Campbell-Arvai, V. 2015. Food-related environmental beliefs and behaviours among university undergraduates: A mixed-methods study. *International Journal of Sustainability in Higher Education*, 16(3):279-295.

Caws, P. 2015. General systems theory: It's past and potential. *Systems Research and Behavioral Science*, 32(5):514-521.

Ceryes, C.A., Antonacci, C.C., Harvey, S.A., Spiker, M.L., Bickers, A. & Neff, R.A. 2021. 'Maybe it's still good?' A qualitative study of factors influencing food waste and application of the EPA Food recovery hierarchy in US supermarkets. *Appetite*, 161:1-11.

Cetindere, A., Duran, C. & Yetisen, M.S. 2015. The effects of total quality management on the business performance: An application in the province of Kütahya. *Procedia Economics and Finance*, 23:1376-1382.

Chalak, A., Abou-Daher, C. & Abiad, M.G. 2018. Generation of food waste in the hospitality and food retail and wholesale sectors: lessons from developed economies. *Food Security*, 10(5):1279-1290.

Chami, K., Gavazzi, G., De Wazières, B., Lejeune, B., Carrat, F., Piette, F. & Rothan-Tondeur, M. 2011. Guidelines for infection control in nursing homes: a Delphi consensus web-based survey. *Journal of Hospital Infection*, 79(1):75-89.

Chang, A.M., Gardner, G.E., Duffield, C. & Ramis, M.A. 2010. A Delphi study to validate an advanced practice nursing tool. *Journal of Advanced Nursing*, 66(10):2320-2330.

Charlebois, S., Creedy, A. & Von Massow, M. 2015. 'Back of house'-focused study on food waste in fine dining: the case of Delish restaurants. *International Journal of Culture, Tourism and Hospitality Research*, 9(3):278-291.

Chen, C.T., Cheng, C.C. & Hsu, F.S. 2015. GRSERV scale: an effective tool for measuring consumer perceptions of service quality in green restaurants. *Total Quality Management & Business Excellence*, 26(3-4):355-367.

Chen, D. & Stroup, W. 1993. General system theory: Toward a conceptual framework for science and technology education for all. *Journal of Science Education and Technology*, 2(3):447-459.

Chen, M.F. 2009. Attitude toward organic foods among Taiwanese as related to health consciousness, environmental attitudes, and the mediating effects of a healthy lifestyle. *British Food Journal*, 1112:165-178.

Cherryholmes, C.H. 1992. Notes on pragmatism and scientific realism. *Educational Researcher*, 21(6):13-17.

Chiang, C.F. & Jang, S.S. 2008. An expectancy theory model for hotel employee motivation. *International Journal of Hospitality Management*, 27(2):313-322.

Chiffoleau, Y., Millet-Amrani, S., Rossi, A., Rivera-Ferre, M.G. & Merino, P.L. 2019. The participatory construction of new economic models in short food supply chains. *Journal of Rural Studies*, 68:182-190.

Chikere, C.C. & Nwoka, J. 2015. The systems theory of management in modern day organisations-a study of Aldgate congress resort limited Port Harcourt. *International Journal of Scientific and Research Publications*, 5(9):1-7.

Choi, G. & Parsa, H.G. 2007. Green practices II: Measuring restaurant managers' psychological attributes and their willingness to charge for the “Green Practices”. *Journal of Foodservice Business Research*, 9(4):41-63.

Christ, K.L. & Burritt, R. 2017. Material flow cost accounting for food waste in the restaurant industry. *British Food Journal*, 1193:600-612.

Churchman, C.W. 1968. *The Systems Approach*. New York, USA: Delacorte Press.

Clairfield International. 2017. *Foodservice spotlight*. [Online] Available from:http://www.clairfield.com/wp-content/uploads/Foodservice-spotlight-2018.03-1.pdf [Accessed: 2018-11-15].

Clean Technology Centre, Cork Institute of Technology. 2014. *Reducing Food Waste in Irish Healthcare Facilities: Results, Guidance and Tips from a 3-Year Programme.* [Online] Available from: https://www.epa.ie/pubs/reports/green%20business/Reducing-food-waste-in-Irish-healthcare-Facilities-foodwaste-guidance-booklet-reduced-size.pdf [Accessed: 2016-11-11].

Cloninger, B.J. 1986. Food item inventory instructional simulation using microcomputers. Unpublished masters' dissertation. Oregon: Oregon State University. [Online] Available from: https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/2b88qf95j [Accessed: 2017-05-25].

Commission for Environmental Cooperation. 2017. *Characterisation and management of food waste in North America.* [Online] Available from: http://www3.cec.org/islandora/en/item/11774-characterization-and-management-food-waste-in-north-america-foundational-report-en.pdf [Accessed: 2019-04-03].

Cornell, C. & Jude, N. 2015. The systems theory of management in modern day organisations. *International Journal of Scientific and Research Publications*, 5(9):1-7.

Corning, P.A. 2014. Systems theory and the role of synergy in the evolution of living systems. *Systems Research and Behavioral Science*, 31(2):181-196.

Costello, C., Birisci, E. & McGarvey, R.G. 2016. Food waste in campus dining operations: Inventory of pre-and post-consumer mass by food category, and estimation of embodied greenhouse gas emissions. *Renewable Agriculture and Food Systems*, 31(3):191-201.

Creedon, M., Cunningham, D. & Hogan, J. 2010. *Less Food Waste More Profit. A Guide to Minimising Food Waste in the Catering Sector.* [Online] Available from: https://www.foodwaste.ie/web-images/Food-Waste-Prevention-Guide.pdf [Accessed: 2016-10-11].

Cremer, M.L. & Chipley, J.R. 1979. Time and temperature, microbiological and sensory quality of meat loaf in a commissary foodservice system transporting heated food. *Journal of Food Science*, 442:317-321.

Creswell, J.W. 2014. *Research design: qualitative, quantitative and mixed methods approaches.* 4th ed. UK: London, Sage.

Creswell, J.W. & Miller, D.L. 2000. Determining validity in qualitative inquiry. *Theory Into Practice*, *39*(3), 124-130. [Online] Available from: https://www.tandfonline.com/doi/pdf/10.1207/s15430421tip3903_2 [Accessed on: 2019-03-05].

Creswell, J.W. & Plano Clark, V.L. 2011. *Designing and conducting mixed methods research.* Thousand Oaks, CA: SAGE.

Cronjé, N., Van der Merwe, I. & Müller, I. M. 2018. Household food waste: A case study in Kimberley, South Africa. *Journal of Consumer Sciences*, 46.

Cuéllar, A.D. & Webber, M.E. 2010. Wasted food, wasted energy: the embedded energy in food waste in the United States. *Environmental Science & Technology*, *44*16:6464-6469.

Dabestani, R., Taghavi, A. & Saljoughian, M. 2014. The relationship between total quality management critical success factors and knowledge sharing in a service industry. *Management and Labour Studies*, 39(1):81-101.

Dauner, K.N., Lacaille, L.J., Schultz, J.F., Harvie, J., Klingner, J., Lacaille, R. & Branovan, M. 2011. Implementing healthy and sustainable food practices in a hospital cafeteria: A qualitative look at processes, barriers, and facilitators of implementation. *Journal of Hunger & Environmental Nutrition*, 6(3):264-278.

Dávila-Aviña J.E., Solís-Soto L.Y., Rojas-Verde G. & Salas N.A. 2015. Sustainability and Challenges of Minimally Processed Foods. In: Siddiqui M., Rahman M. (eds). *Minimally Processed Foods*. Food Engineering Series. Springer, Cham.

Davis, B., Lockwood, A., Alcott, P. & Pantelidis, I. 2012. *Food and Beverage Management*. 5th ed. Oxon, UK: Routledge.

De Boeck, E., Jacxsens, L., Bollaerts, M. & Vlerick, P. 2015. Food safety climate in food processing organizations: development and validation of a self-assessment tool. *Trends in Food Science & Technology*, 46(2):242-251.

De Hooge, I.E., Van Dulm, E. & Van Trijp, H.C. 2018. Cosmetic specifications in the food waste issue: Supply chain considerations and practices concerning suboptimal food products. *Journal of Cleaner Production*, 183:698-709.

De Lange, W. & Nahman, A. 2015. Costs of food waste in South Africa: Incorporating inedible food waste. *Waste Management*, 40:167-172.

De Moraes, C.C., De Oliveira Costa, F.H., Pereira, C.R., Da Silva, A.L. & Delai, I. 2020. Retail food waste: Mapping causes and reduction practices. *Journal of Cleaner Production*, 256(120124): 1-16.

De Steur, H., Wesana, J., Dora, M.K., Pearce, D. & Gellynck, X. 2016. Applying value stream mapping to reduce food losses and wastes in supply chains: A systematic review. *Waste Management*, 58:359-368.

De Vos, A.S., Strydom, H., Fouche. C.B. & Delport, C.S.L. 2011. *Research at grass roots: for the social sciences and human service professions.* Van Schaik, Pretoria: Hatfield.

Department of Residence Affairs and Accommodation. 2018. *Student Accommodation.* [Online] Available from: https://www.up.ac.za/student-accommodation [Accessed: 2019-02-03].

Derqui, B., Fayos, T. & Fernandez, V. 2016. Towards a more sustainable food supply chain: Opening up invisible waste in food service. *Sustainability*, 8(7):693.

Deutsche Welle. 2018. *Waste food and emissions: Landfill or the plate?* [Online] Available from: https://www.dw.com/en/waste-food-and-emissions-landfill-or-the-plate/a-46591609 [Accessed: 2018-12-09].

Dewald, B., Bruin, B.J. & Jang, Y.J. 2014. US consumer attitudes towards 'green' restaurants. *Anatolia*, 25(2):171-180.

DiPietro, B.R., Cao, Y. & Partlow, C. 2013. Green practices in upscale foodservice operations: Customer perceptions and purchase intentions. *International Journal of Contemporary Hospitality Management*, *25*(5):779-796.

DiPietro, R.B., Gregory, S. & Jackson, A. 2013. Going green in quick-service restaurants: Customer perceptions and intentions. *International Journal of Hospitality & Tourism Administration*, 14(2):139-156.

Do Carmo Stangherlin, I. & De Barcellos, M. D., 2018. Drivers and barriers to food waste reduction. *British Food Journal*, 120(10):2364-2387.

Doody, O. & Noonan, M. 2013. Preparing and conducting interviews to collect data. *Nurse Researcher*, *20*(5).

Dogan, H., Nebioglu, O. & Demirag, M. 2015. A comparative study for green management practices in Rome and Alanya restaurants from managerial perspectives. *Journal of Tourism and Gastronomy Studies*, 3(11).

Dou, Z., Ferguson, J.D., Galligan, D.T., Kelly, A.M., Finn, S.M. & Giegengack, R. 2016. Assessing US food wastage and opportunities for reduction. *Global Food Security*, 8:19-26.

Drack, M. & Schwarz, G. 2010. Recent developments in general system theory. *Systems Research and Behavioral Science*, 27(6):601-610.

Dutta, K., Umashankar, V., Choi, G. & Parsa, H.G. 2008. A comparative study of consumers' green practice orientation in India and the United States: A study from the restaurant industry. *Journal of Foodservice Business Research*, 11(3):269-285.

Edwards, J.S. 2013. The foodservice industry: Eating out is more than just a meal. *Food Quality and Preference*, 272:223-229.

Edwards, J.S. & Causa, H. 2009. What is food service? *Journal of Foodservice*, 201:1-3.

Edwards, J.S. & Hartwell, H.J. 2006. Hospital food service: a comparative analysis of systems and introducing the 'Steamplicity' concept. *Journal of Human Nutrition and Dietetics*, 19(6):421-430.

Edwards, J.S. & Nash, A.H. 1999. The nutritional implications of food wastage in hospital food service management. *Nutrition & Food Science*, 992:89-98.

Efstathiou, N., Coll, A.M., Ameen, J. & Daly, W. 2011. Do Greek healthcare users and healthcare providers share cancer care priorities? Analysing the results from two Delphi studies. *European Journal of Cancer Care*, 20(2):179-186.

Engström, R. & Carlsson-Kanyama, A. 2004. Food losses in food service institutions Examples from Sweden. *Food Policy*, 29(3):203-213.

Eriksson, M., Osowski, C.P., Björkman, J., Hansson, E., Malefors, C., Eriksson, E. & Ghosh, R. 2018. The tree structure — A general framework for food waste quantification in food services. *Resources, Conservation and Recycling*, 130:140-151.

Eriksson, M., Osowski, C.P., Malefors, C., Björkman, J. & Eriksson, E. 2017. Quantification of food waste in public catering services–A case study from a Swedish municipality. *Waste Management*, 61:415-422.

Eriksson, M., Strid, I. & Hansson, P.A. 2015. Carbon footprint of food waste management options in the waste hierarchy–a Swedish case study. *Journal of Cleaner Production*, 93:115-125.

Estrela, M., Roque, F., Silva, T.M., Zapata-Cachafeiro, M., Figueiras, A. & Herdeiro, M.T. 2021. Validation of the eHealthResp online course for pharmacists and physicians: A Delphi method approach. *Biomedicine & Pharmacotherapy*, 140:1-6.

European Union. 2016. *Combating food waste: an opportunity for the EU to improve the resource-efficiency of the food supply chain.* [Online] Available from: https://www.eca.europa.eu/Lists/ECADocuments/SR16_34/SR_FOOD_WASTE_EN.pdf [Accessed: 2017-11-18].

Falasconi, L., Vittuari, M., Politano, A. & Segrè, A. 2015. Food waste in school catering: An Italian case study. *Sustainability*, 711:14745-14760.

Faour-Klingbeil, D., Kuri, V., & Todd, E. 2020. Comparison of hygiene standards and food safety practices between sole-proprietor and corporate-managed restaurants in Lebanon. *British Food Journal*, 122(4):1112-1129.

Fan, Y. & Fang, C. 2019. Research on the synergy of urban system operation — Based on the perspective of urban metabolism. *Science of the Total Environment*, 662:446-454.

Feagan, R., Morris, D. & Krug, K. 2004. Niagara region farmers' markets: local food systems and sustainability considerations. *Local Environment*, 9(3):235-254.

Faul, A.C. & Hudson, W.W. 1999. Scale development for research and practice. *Pretoria: Perspective Training College*.

Fefer, J.P., De-Urioste Stone, S., Daigle, J. & Silka, L. 2016. Using the Delphi technique to identify key elements for effective and sustainable visitor use planning frameworks. *Sage Open*, 6(2).

Feilzer, M.Y. 2010. Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research*, 4(1):6-16.

Fening, A.F., Pesakovic, G. & Amaria, P. 2008. Relationship between quality management practices and the performance of small and medium size enterprises (SMEs) in Ghana. *International Journal of Quality & Reliability Management*, 25(7):694-708.

Fennell, D. & Markwell, K. 2015. Ethical and sustainability dimensions of foodservice in Australian ecotourism businesses. *Journal of Ecotourism*, 14(1):48-63.

Fernández-Ávila, D.G., Rojas, M.X. & Rosselli, D. 2020. The Delphi method in rheumatology research: are we doing it right?. *Revista Colombiana de Reumatología (English Edition)*, *27*(3): 177-189.

Ferreira, M., Liz Martins, M. & Rocha, A. 2013. Food waste as an index of foodservice quality. *British Food Journal*, 115(11):1628-1637.

Filimonau, V. & De Coteau, A. 2019. Food waste management in hospitality operations: A critical review. *Tourism Management*, 71:234-245.

Filimonau, V., Fidan, H., Alexieva, I., Dragoev, S. & Marinova, D.D. 2019. Restaurant food waste and the determinants of its effective management in Bulgaria: An exploratory case study of restaurants in Plovdiv. *Tourism Management Perspectives*, 32:1-11.

Filimonau, V., Todorova, E., Mzembe, A., Sauer, L. & Yankholmes, A. 2020. A comparative study of food waste management in full service restaurants of the United Kingdom and the Netherlands. *Journal of Cleaner Production*, 258:1-12.

Filimonau, V., Zhang, H. & Wang, L.E. 2020. Food waste management in Shanghai full-service restaurants: A senior managers' perspective. *Journal of Cleaner Production*, 258:1-13.

Flood, R.L. 1993. *Beyond TQM.* West Sussex, UK: John Wiley.

Folch-Lyon, E. & Trost, J.F. 1981. Conducting focus group sessions. *Studies in family planning*, 443-449.

Food and Agricultural Organisation. 2014. *Definitional Framework of Food Loss*. [Online] Available from: http://www.fao.org/fileadmin/user_upload/save-food/PDF/FLW_Definition_and_Scope_2014.pdf [Accessed: 2016-11-13].

Food Use for Social Innovation by Optimising Waste Prevention Strategies (FUSIONS). 2016. *Estimates of European Food Waste Levels.* [Online] Available from: https://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf [Accessed: 2015-12-12].

Ford, J.D., Berrang-Ford, L. & Paterson, J. 2011. A systematic review of observed climate change adaptation in developed nations. *Climatic Change*, 106(2):327-336.

Forman, J. & Silverstein, J. 2012. Organic foods: health and environmental advantages and disadvantages. *Pediatrics*, 1305:e1406-e1415.

Fotopoulos, C.V. & Psomas, E.L. 2010. The structural relationships between TQM factors and organizational performance. *The TQM Journal*, 22(5):539-552.

Fotopoulos, C.V., Psomas, E.L., & Vouzas, F.K. 2010. Investigating total quality management practice's inter-relationships in ISO 9001: 2000 certified organisations. *Total Quality Management*, *21*(5):503-515.

Frash, R.E., DiPietro, R. & Smith, W. 2015. Pay more for McLocal? Examining motivators for willingness to pay for local food in a chain restaurant setting. *Journal of Hospitality Marketing & Management*, 244:411-434.

Freedman, M.R. & Brochado, C. 2010. Reducing portion size reduces food intake and plate waste. *Obesity*, 189:1864-1866.

Freshwater, J.F. 1969. Future of food service systems. *Cornell Hotel and Restaurant Administration Quarterly*, 10(3):28-31.

Frey, B.B. 2018. *The sage encyclopedia of educational research, measurement and research.* London, UK: SAGE.

Friese, S. 2019. *Qualitative Data Analysis with ATLAS.ti .* 3rd ed. London, UK: SAGE.

Fuentes, M.M.F., Montes, F.J.L. & Fernández, L.M.M. 2006. Total quality management, strategic orientation and organizational performance: the case of Spanish companies. *Total Quality Management & Business Excellence*, 17(3):303-323.

Garcia-Garcia, G., Woolley, E. & Rahimifard, S. 2015. A framework for a more efficient approach to food waste management. *International Journal of Food Engineering*, 1(1):65-72.

Garg, A. & Kumar, J. 2017. Exploring customer satisfaction with university cafeteria food services. An empirical study of Temptation Restaurant at Taylor's University, Malaysia. *European Journal of Tourism, Hospitality and Recreation*, 82:96-106.

Garrone, P., Melacini, M. & Perego, A. 2014. Opening the black box of food waste reduction. *Food Policy*, 46:129-139.

George, R.V., Harsh, H.O., Ray, P. & Babu, A.K. 2019. Food quality traceability prototype for restaurants using blockchain and food quality data index. *Journal of Cleaner Production*, 240:118021.

Ghanem, M.S. 2020. Profiling food waste in the hospitality industry by exploring restaurant managers' attitudes. *International Journal of Heritage, Tourism and Hospitality*, 14(3):160-174.

Gilbert, L.S., Jackson, K. & Di Gregorio, S. 2014. Tools for analyzing qualitative data: The history and relevance of qualitative data analysis software. In *Handbook of Research on Educational Communications and Technology*. New York, NY: Springer.

Gill, P., Stewart, K., Treasure, E. & Chadwick, B. 2008. Methods of data collection in qualitative research: interviews and focus groups. *British Dental Journal*, 204(6):291.

Gillard, P. 2017. *Assessing and Quantifying Food Waste on the University of Saskatchewan Campus: Developing a Comprehensive Food-Waste Reduction Plan.* Unpublished doctoral thesis. Saskatoon: University of Saskatchewan. [Online] Available from: https://sens.usask.ca/documents/msem-projects/P.Gilliard_Final_Report_30-07-17_Rec%2010-31-17.pdf [Accessed: 2018-02-02]

Gimenez, C. & Tachizawa, E.M. 2012. Extending sustainability to suppliers: a systematic literature review. *Supply Chain Management: An International Journal*, 175:531-543.

Gimenez, C., Sierra, V. & Rodon, J. 2012. Sustainable operations: Their impact on the triple bottom line. *International Journal of Production Economics*, 140(1):149-159.

Girotto, F., Alibardi, L. & Cossu, R. 2015. Food waste generation and industrial uses: a review. *Waste Management*, 45:32-41.

Gładysz, B., Buczacki, A. & Haskins, C. 2020. Lean management approach to reduce waste in HoReCa food services. *Resources*, 9(12):144.

Glenn, S.S. & Malott, M.E. 2004. Complexity and selection: Implications for organisational change. *Behavior and Social Issues*, 13(2):89-106.

Goh, E. & Jie, F. 2019. To waste or not to waste: Exploring motivational factors of Generation Z hospitality employees towards food wastage in the hospitality industry. *International Journal of Hospitality Management*, 80:126-135.

Goldkuhl, G. 2012. Activity Cycles in Design Research: A Pragmatic Conceptualisation of Inter-related Practices. In *European Design Science Symposium*, 49-60.

Gollnick, V., Stumpf, E., Szodruch, J. & Lehner, S. 2011. Virtual Integration Platforms (VIP)-A concept for Integrated and Interdisciplinary Air Transportation Research and Assessment. In *11th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, including the AIAA Balloon Systems Conference and 19th AIAA Lighter-Than*, 6889.

Goonan, S., Mirosa, M. & Spence, H. 2014. Getting a taste for food waste: a mixed methods ethnographic study into hospital food waste before patient consumption conducted at three New Zealand foodservice facilities. *Journal of the Academy of Nutrition and Dietetics*, 114(1):63-71.

Goonan, S., Mirosa, M. & Spence, H. 2014. Systems-practice framework: an integrated approach for foodservice management. *Nutrition & Dietetics*, 72(1):81-90.

Gossler, T., Sigala, I.F., Wakolbinger, T. & Buber, R. 2019. Applying the Delphi method to determine best practices for outsourcing logistics in disaster relief. *Journal of Humanitarian Logistics and Supply Chain Management*, 9(3):438-474.

Govindan, K. 2018. Sustainable consumption and production in the food supply chain: A conceptual framework. *International Journal of Production Economics*, 195:419-431.

Grandin, T. 2014. Animal welfare and society concerns finding the missing link. *Meat Science*, 983:461-469.

Graunke, R.E. & Wilkie, A.C. 2008. Converting food waste to biogas: Sustainable gator dining. *Sustainability,* 1(6):391-394.

Green Restaurant Association. 2015. *Green restaurant certification standards.* [Online] Available from: https://www.dinegreen.com/certification-standards [Accessed: 2016-05-08].

Gregoire, M. 2017. *Food service organizations: A managerial and systems approach*. 9th ed. Boston: Pearson.

Grisham, T. 2009. The Delphi technique: a method for testing complex and multifaceted topics. *International Journal of Managing Projects in Business*, 2(1):112-130.

Gue, R.L. 1969. An introduction to the systems approach in the dietary department. *Hospitals*, 43(17):100-101.

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R. & Meybeck, A. 2011. *Global Food Losses and Food Waste*, 1-38. Rome: FAO.

Halloran, A., Clement, J., Kornum, N., Bucatariu, C. & Magid, J. 2014. Addressing food waste reduction in Denmark. *Food Policy*, 49:294-301.

Hammond, D. & Wilby, J. 2006. The life and work of James Grier Miller. Systems Research and Behavioral Science*. The Official Journal of the International Federation for Systems Research*, 23(3):429-435.

Hansson, J. 2003. *Total quality management — aspect of implementation and performance: investigations with a focus on small organisations.* Unpublished doctoral thesis. Luleå: Luleå University of Technology [Online] Available from: https://www.diva-portal.org/smash/get/diva2:999931/FULLTEXT01.pdf [Accessed: 2016-12-12].

Harper, G. & Henson, S. 2001. Consumer concerns about animal welfare and the impact on food choice. *EU FAIR CT98-3678, Centre for Food Economics Research, The University of Reading*.

Harper, G.C. & Makatouni, A. 2002. Consumer perception of organic food production and farm animal welfare. *British Food Journal*, *104*3/4/5:287-299.

Hasan, M. & Kerr, R.M. 2003. The relationship between total quality management practices and organisational performance in service organisations. *The TQM Magazine*, 15(4):286-291.

Hasson, F. & Keeney, S. 2011. Enhancing rigour in the Delphi technique research. *Technological Forecasting and Social Change*, 78(9):1695-1704.

Heikkilä, L., Reinikainen, A., Katajajuuri, J.M., Silvennoinen, K. & Hartikainen, H. 2016. Elements affecting food waste in the food service sector. *Waste Management*, 56:446-453.

Heller, M.C. & Keoleian, G.A. 2003. Assessing the sustainability of the US food system: a life cycle perspective. *Agricultural Systems*, 763:1007-1041.
Hennchen, B. 2019. Knowing the kitchen: Applying practice theory to issues of food waste in the food service sector. *Journal of Cleaner Production*, 225:675-683.

Hennink, M., Hutter, I. & Bailey, A. 2010. *Qualitative Research Methods*. London: Sage.
Her, E., Seo, S., Choi, J., Pool, V. & Ilic, S. 2019. Assessment of food safety at university food courts using surveys, observations, and microbial testing. *Food Control*, 103:167-174.

High Level Panel of Experts on Food Security and Nutrition. 2017. *Nutrition and Food Systems*. [Online] Available from: http://www.fao.org/3/a-i7846e.pdf [Accessed: 2018-05-27].

Hilario, J.S. 2014. Responsiveness of fast-food chain managers along Far Eastern University (FEU-Manila) towards the implementation of green practices in restaurants. *Journal Issues,* 1(9):183-191.

Hoang, D.T., Igel, B. & Laosirihongthong, T. 2006. The impact of total quality management on innovation. *International Journal of Quality & Reliability Management*, 23(9):1092-1117.

Honarpour, A., Jusoh, A. & Long, C.S. 2017. Knowledge management and total quality management: a reciprocal relationship. *International Journal of Quality & Reliability Management*, 341:91-102.

Horgan, R. & Gavinelli, A. 2006. The expanding role of animal welfare within EU legislation and beyond. *Livestock Science*, 1033:303-307.

Hsu, C.C. & Sandford, B.A. 2012. The Delphi technique: Use, considerations, and applications in the conventional, policy, and on-line environments. In *Online research methods in urban and planning studies: Design and outcomes,* 173-192.

Hu, H.H., Parsa, H.G. & Self, J. 2010. The dynamics of green restaurant patronage. *Cornell Hospitality Quarterly*, 51(3):344-362.

Huang, E., Gregoire, M.B., Tangney, C. & Stone, M.K. 2011. Sustainability in hospital foodservice. *Journal of Foodservice Business Research*, 14(3):241-255.

Hughner, R.S., McDonagh, P., Prothero, A., Shultz, C.J. & Stanton, J. 2007. Who are organic food consumers? A compilation and review of why people purchase organic food. *Journal of Consumer Behaviour: An International Research Review*, 62-3:94-110.

Husin, N.H. & Kler, B.K. 2014. The Influence of Stressors on Individual Job Performance of Employees in Restaurant and Catering Industry. *Association of Global Management Studies*, 17.

Hwang, J.H. & Sneed, J. 2009. Comparison of centralized and conventional food production systems in school districts using the analytic hierarchy process. *Journal of Foodservice Business Research*, 124:384-402.

Hwang, S. 2008. Utilizing qualitative data analysis software: A review of Atlas.ti. *Social Science Computer Review*, 26(4):519-527.

Iaquinto, A. 2014. Sustainable practices among independently owned restaurants in Japan. *Journal of Foodservice Business Research*, 17(2):147-159.

Ilbery, B. & Maye, D. 2006. Retailing local food in the Scottish–English borders: A supply chain perspective. *Geoforum*, 37(3):352-367.

International Tourism Partnership. 2014. *Know how guide to reducing and managing food waste in hotels.* [Online] Available from: http://www.greenhotelier.org/wp-content/uploads/2014/09/Know-How-Guide-on-Managing-and-Reducing-Food-Waste.pdf [Accessed: 2016-10-11].

Inter-American Institute for Cooperation on Agriculture. 2009. *Good Manufacturing Practices*. [Online] Available from http://repiica.iica.int/docs/B2217i/B2217i.pdf [Accessed: 2017-08-12].

Irish Environmental Protection Agency. 2014. *Reducing food waste in Irish healthcare facilities.* [Online] Available from: https://www.epa.ie/pubs/reports/green%20business/Reducing-food-waste-in-Irish-healthcare-Facilities-foodwaste-guidance-booklet-reduced-size.pdf [Accessed: 2016-09-09].

Irvine, A., Drew, P. & Sainsbury, R. 2012. 'Am I not answering your questions properly?' Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews. *Qualitative Research*, 13(1):87-106.

Jaca, C. & Psomas, E. 2015. Total quality management practices and performance outcomes in Spanish service companies. *Total Quality Management & Business Excellence*, 26(9-10):958-970.

Jackson, A., Boswell, K. & Davis, D. 2011. Sustainability and triple bottom line reporting – What is it all about. *International Journal of Business, Humanities and Technology*, 1(3):55-59.

Jaeger, M. & Adair, D. 2016. Perception of TQM benefits, practices and obstacles. *The TQM Journal*, 28(2):317-336.

Jagustović, R., Zougmoré, R.B., Kessler, A., Ritsema, C.J., Keesstra, S. & Reynolds, M. 2019. Contribution of systems thinking and complex adaptive system attributes to sustainable food production: Example from a climate-smart village. *Agricultural Systems*, 171:65-75.

Jang, Y.J., Kim, W.G. & Bonn, M.A. 2011. Generation Y consumers' selection attributes and behavioural intentions concerning green restaurants. *International Journal of Hospitality Management*, 30(4):803-811.

Járos, G. 2000. Living systems theory of James Grier Miller and teleonics. *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research*, 17(3):289-300.

Jeong, E. & Jang, S.C. 2010. Effects of restaurant green practices: Which practices are important and effective? *Caesars Hospitality Research Summit*, 13.

Jeong, E., Jang, S.S., Day, J. & Ha, S. 2014. The impact of eco-friendly practices on green image and customer attitudes: An investigation in a café setting. *International Journal of Hospitality Management*, 41:10-20.

Jesson, J., Matheson, L. & Lacey, F.M. 2011. *Doing your literature review: Traditional and systematic techniques*. London,UK: SAGE.

Johl, S.K. & Renganathan, S. 2010. Strategies for gaining access in doing fieldwork: Reflection of two researchers. *Electronic Journal of Business Research Methods*, *8*(1):42. [Online] Available from: www.ejbrm.com [Accessed: 2019-02-24].

Johnson, R.A., Kast, F.E. & Rosenzweig, J.E. 1964. Systems theory and management. *Management Science*, 10(2):367-384.

Johnson, R.B. & Onwuegbuzie, A.J. 2004. Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, 33(7):14-26.

Joiner, T.A. 2007. Total quality management and performance: The role of organization support and co-worker support. *International Journal of Quality & Reliability Management*, 24(6):617-627.

Jorgensen, D.L. 2015. Participant observation. *Emerging trends in the social and behavioural sciences: An interdisciplinary, searchable, and linkable resource*, 1-15.

Jung, J.Y. & Wang, Y.J. 2006. Relationship between total quality management TQM and continuous improvement of international project management CIIPM. *Technovation*, 265-6:716-722.

Kahreh, Z.S., Shirmohammadi, A. & Kahreh, M.S. 2014. Explanatory study towards analysis the relationship between Total Quality Management and Knowledge Management. *Procedia-Social and Behavioral Sciences*, 109:600-604.

Kallbekken, S. & Sælen, H. 2013. 'Nudging' hotel guests to reduce food waste as a win–win environmental measure. *Economics Letters*, 1193:325-327.

Kaluarachchi, K.A.S.P. 2010. Organizational culture and total quality management practices: a Sri Lankan case. *The TQM Journal*, 22(1):41-55.

Kandiah, J., Stinnett, L. & Lutton, D. 2006. Visual plate waste in hospitalized patients: length of stay and diet order. *Journal of the American Dietetic Association*, 10610:1663-1666.

Kantor, L.S., Lipton, K., Manchester, A. & Oliveira, V. 1997. Estimating and addressing America's food losses. *Food Review/National Food Review*, 20(1):2-12.

Karia, N. & Asaari, M.H.A.H. 2006. The effects of total quality management practices on employees' work- related attitudes. *The TQM Magazine*, 18(1):30-43.

Kasavan, S., Mohamed, A.F. & Halim, S.A. 2018. Knowledge and attitudes of hoteliers in Langkawi UNESCO Global Geopark towards Sustainable Food Waste Management (SFWM). *Pertanika Journal of Social Sciences & Humanities*, 26(3):1941-1955.

Kasavan, S., Mohamed, A.F. & Halim, S.A. 2019. Drivers of food waste generation: Case study of island-based hotels in Langkawi, Malaysia. *Waste Management*, 91:72-79.

Kassier, S. & Veldman, F. 2013. Food security status and academic performance of students on financial aid: The case of University of KwaZulu-Natal. *Alternation*, 9:248-264.

Kast, F.E. & Rosenzweig, J.E. 1972. General systems theory: Applications for organisation and management. *Academy of Management Journal*, 15(4):447-465.

Kasza, G., Szabó-Bódi, B., Lakner, Z. & Izsó, T. 2019. Balancing the desire to decrease food waste with requirements of food safety. *Trends in Food Science & Technology*, 84:74-76.

Katajajuuri, J. M., Silvennoinen, K., Hartikainen, H., Heikkilä, L. & Reinikainen, A. 2014. Food waste in the Finnish food chain. *Journal of Cleaner Production*, 73:322-329.

Kaynak, H. 2003. The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management*, 21(4):405-435.

Ketikidis, P.H., Koh, S. L., Gunasekaran, A., Demirbag, M., Tatoglu, E., Tekinkus, M. & Zaim, S. 2006. An analysis of the relationship between TQM implementation and organizational performance. *Journal of Manufacturing Technology Management*, 17(6):829-847.

Kim, D.Y., Kumar, V. & Kumar, U. 2012. Relationship between quality management practices and innovation. *Journal of Operations Management*, 30(4):295-315.

Kim, K. & Morawski, S. 2012. Quantifying the impact of going trayless in a university dining hall. *Journal of Hunger & Environmental Nutrition*, *7*(4):482-486.

Kim, M., Jang, Y.C. & Lee, S. 2013. Application of Delphi-AHP methods to select the priorities of WEEE for recycling in a waste management decision-making tool. *Journal of Environmental Management*, 128:941-948.

Kim, T. & Freedman, M.R. 2010. Students reduce plate waste through education and trayless dining in an all-you-can-eat college dining facility. *Journal of the American Dietetic Association*, 110(9):A68.

Kim, Y.J., Njite, D. & Hancer, M. 2013. Anticipated emotion in consumers' intentions to select eco-friendly restaurants: Augmenting the theory of planned behaviour. *International Journal of Hospitality Management*, 34:255-262.

Kinasz, T.R., Reis, R.B. & Morais, T.B. 2015. Presentation of a validated checklist as a tool for assessing, preventing and managing food waste in foodservices. *Food and Nutrition Sciences*, 6(11):985-991.

Kislov, R. 2018. Selective permeability of boundaries in a knowledge brokering team. *Public Administration*, 96(4):817-836.

Ko, W.H. 2013. The relationship among food safety knowledge, attitudes and self-reported HACCP practices in restaurant employees. *Food Control*, 29(1):192-197.

Ko, W.H. & Lu, M.Y. 2020. Evaluation of the professional competence of kitchen staff to avoid food waste using the modified Delphi method. *Sustainability*, 12(19):1-11.

Konnersman, P.M. 1969. Forecasting production demand in the dietary department. *Hospitals*, 43(18):85-7.

Koontz, H., & O'Donnell, C. 1972. *Principles of management: An analysis of managerial functions*. New York, NY: McGraw-Hill.

Kotsanopoulos, K.V. & Arvanitoyannis, I.S. 2017. The role of auditing, food safety, and food quality standards in the food industry: A review. *Comprehensive Reviews in Food Science and Food Safety*, 16(5):760-775.

Kranert, M., Kusch, S., Huang, J. & Fischer, K. 2012. Anaerobic digestion of waste. In *Waste to Energy*, 107-135. London: Springer.

Kristianto, Y., Ajmal, M.M. & Sandhu, M. 2012. Adopting TQM approach to achieve customer satisfaction: A flour milling company case study. *The TQM Journal*, 24(1):29-46.

Krittanathip, V., Rakkarn, S., Cha-um, S. & Konkhum, P. 2013. Development of Weighting on Self-assessment Evaluation for Total Quality Management: A Case Study of Retail Sectors. *Procedia-Social and Behavioral Sciences*, 88:37-48.

Krueger, R.A. & Casey, M. 2014. *Focus groups: a practical guide for applied research*. 3rd ed. Thousand Oaks, Carlifornia, CA: SAGE.

Kruger, L. ., Rodgers, R.F., Long, S.J. & Lowy, A.S. 2019. Individual interviews or focus groups? Interview format and women's self-disclosure. *International Journal of Social Research Methodology*, 22(3):245-255.

Kucukvar, M. & Tatari, O. 2013. Towards a triple bottom-line sustainability assessment of the US construction industry. *The International Journal of Life Cycle Assessment*, 18(5):958-972.

Kulikovskaja, V. & Aschemann-Witzel, J. 2017. Food waste avoidance actions in food retailing: The case of Denmark. *Journal of International Food & Agribusiness Marketing*, 29(4):328-345.

Kumar, U., Kumar, V., De Grosbois, D. & Choisne, F. (2009). Continuous improvement of performance measurement by TQM adopters. *Total Quality Management*, 20(6):603-616.

Kwok, L., Huang, Y.K. & Hu, L. 2016. Green attributes of restaurants: What really matters to consumers?. *International Journal of Hospitality Management*, 55:107-117.

Lai, C.H. & Huili Lin, S. 2017. Systems theory. *The International Encyclopaedia of Organizational Communication*, 1-18.

Lam, Y. 2010. Why do UC Berkeley students waste food at dining halls? [Online] Available from: http://nature.berkeley.edu/classes/es196/projects/2010final/LamY_2010.pdf [Accessed: 2016-02-03].

Lashley, C. 1995. Towards an understanding of employee empowerment in hospitality services. *International Journal of Contemporary Hospitality Management*, 7(1):27-32.

Lazarides, H.N. 2011. Food processing technology in a sustainable food supply chain. *Procedia Food Science*, 1:1918-1923.

Le Roux, C.R. 2017. *The extent and drivers of perishable food waste in the retail supply chain industry of South Africa*. Unpublished Doctoral dissertation. Pretoria: University of Pretoria. [Online] Available from: https://repository.up.ac.za/bitstream/handle/2263/64863/Le%20Roux_Extent_2018.pdf?sequence=1&isAllowed=y [Accessed: 2018-03-02].

Leal Filho, W., Azeiteiro, U.M. & Azul, A. 2016. *Climate change and health*. Berlin, Germany: Springer.

LeanPath. 2016. *20 Waste cutting tips every food service chef should know* [Online]. Available: http://info.leanpath.com/20-food-waste-cutting-tips-guide [Accessed 09/09/2017].

Leedy, P. & Ormrod, J. 2001. *Practical Research: Planning and Design*. 7th ed. Thousand Oaks, California, CA: SAGE.

Lefadola, B.P., Viljoen, A. & Du Rand, G.E. 2018. A Systems Approach to Food Waste Prevention in Food Service Operations: An Integrative Review. *African Journal of Hospitality, Tourism and Leisure,* 7(4).

Lehtinen, U. 2012. Sustainability and local food procurement: a case study of Finnish public catering. *British Food Journal*, 1148:1053-1071.

Leighninger Jr, R.D. 1978. Systems theory. *The Journal of Sociology & Social Welfare,* 5:446.

Lewis, A., Elmualim, A. & Riley, D. 2011. Linking energy and maintenance management for sustainability through three American case studies. *Facilities*, 295(6):243-254.

Lewis, J.D. 1976. The classic American pragmatists as forerunners to symbolic interactionism. *The Sociological Quarterly*, 17(3):347-359.

Li, D., Wang, X., Chan, H.K. & Manzini, R. 2014. Sustainable food supply chain management. *International Journal of Production Economics*, 152:1-8.

Li, J.H., Anderson, A.R. & Harrison, R.T. 2003. Total quality management principles and practices in China. *International Journal of Quality & Reliability Management*, *20*(9):1026-1050.

Liamputtong, P. 2011. *Focus Group Methodology: Principles and Practice.* London, UK: SAGE.

Lilienfeld, R. 1975. Systems theory as an ideology. *Social Research*, 637-660.

Lipińska, M., Tomaszewska, M. & Kołożyn-Krajewska, D. 2019. Identifying factors associated with food losses during transportation: Potentials for social purposes. *Sustainability*, 11(7):1-15.

Löfmark, A. & Mårtensson, G. 2017. Validation of the tool assessment of clinical education (AssCE): A study using Delphi method and clinical experts. *Nurse Education Today*, 50:82-86.

Lundqvist, J., De Fraiture, C. & Molden, D. 2008. *Saving water: from field to fork: curbing losses and wastage in the food chain*. [Online] Available from: https://www.siwi.org/wp-content/uploads/2015/09/PB_From_Field_to_Fork_2008.pdf [Accessed: 2016-08-09].

Luu, T.T. 2020. Reducing food waste behaviour among hospitality employees through communication: dual mediation paths. *International Journal of Contemporary Hospitality Management*, 32(5):1881-1904.

Ma, J. & Ghiselli, R. 2016. Measuring, monitoring, and managing the green practices in mid-sized restaurants in China. *Journal of Foodservice Business Research*, 19(1):64-76.

Mabaso, C.H. 2017. *Food waste management within a hotel group in Gauteng*. Unpublished masters dissertation. Johannesburg: University of Johannesburg. [Online Available from: https://ujcontent.uj.ac.za/vital/access/manager/Repository/uj:28905/SOURCE1 [Accessed: 2018-05-12]

Mabogunje, A.L. 1970. Systems approach to a theory of rural-urban migration. *Geographical Analysis*, 2(1):1-18.

Macdiarmid, J.I. 2013. Seasonality and dietary requirements: will eating seasonal food contribute to health and environmental sustainability? *Proceedings of the Nutrition Society*, 73(3):368-375.

Macdiarmid, J.I., Kyle, J., Horgan, G.W., Loe, J., Fyfe, C., Johnstone, A. & McNeill, G. 2012. Sustainable diets for the future: can we contribute to reducing greenhouse gas emissions by eating a healthy diet? *The American Journal of Clinical Nutrition*, 96(3):632-639.

Maguire, M. & Delahunt, B. 2017. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *AISHE-J: The All Ireland Journal of Teaching and Learning in Higher Education*, 9(3).

Malterud, K., Siersma, V.D. & Guassora, A. D. 2015. Sample size in qualitative interview studies: guided by information power. *Qualitative Health Research*, 26(13):1753-1760.

Manzini, R. & Accorsi, R. 2013. The new conceptual framework for food supply chain assessment. *Journal of Food Engineering*, 115(2):251-263.

Manzocco, L., Alongi, M., Lagazio, C., Sillani, S. & Nicoli, M.C. 2017. Effect of temperature in domestic refrigerators on fresh-cut Iceberg salad quality and waste. *Food Research International*, 102:129-135.

Marais, M. L., Smit, Y., Koen, N. & Lötze, E. 2017. Are the attitudes and practices of foodservice managers, catering personnel and students contributing to excessive food wastage at Stellenbosch University? *South African Journal of Clinical Nutrition*, 30(3):60-67.

Maree, K. 2007. *First steps in research.* Van Schaik: Pretoria, South Africa.

Marin-Garcia, J. A., Juarez-Tarraga, A. & Santandreu-Mascarell, C. 2018. Kaizen philosophy: the keys of the permanent suggestion systems analysed from the workers' perspective. *The TQM Journal*, 30(4):296-320.

Marthinsen, J., Sundt, P., Kaysen, O. & Kirkevaag, K. 2012. *Prevention of food waste in restaurants, hotels, canteens and catering*. Copenhagen, Denmark: Nordic Council of Ministers.

Martin-Rios, C., Demen-Meier, C., Gössling, S. & Cornuz, C. 2018. Food waste management innovations in the foodservice industry. *Waste Management*, 79:196-206.

Martínez-Lorente, A.R., Dewhurst, F. & Dale, B.G. 1998. Total quality management: origins and evolution of the term. *The TQM Magazine*, 10(5):378-386.

Mavrommatis, Y., Moynihan, P.J., Gosney, M.A. & Methven, L. 2011. Hospital catering systems and their impact on the sensorial profile of foods provided to older patients in the UK. *Appetite*, 57(1):14-20.

Maxcy, S.J. 2003. Pragmatic threads in mixed methods research in the social sciences: The search for multiple modes of inquiry and the end of the philosophy of formalism. *Handbook of mixed methods in social and behavioural research*, 51-89.

Mays, N. & Pope, C. 2006. Quality in qualitative health research. *Qualitative research in health care*, 3:82-101.

McAdams, B., Von Massow, M., Gallant, M. & Hayhoe, M.A. 2019. A cross industry evaluation of food waste in restaurants. *Journal of Foodservice Business Research*, 22(5):449-466.

McLafferty, I. 2004. Focus group interviews as a data collecting strategy. *Journal of Advanced Nursing*, 48(2):187-194.

Mease, L.A., Gibbs-Plessl, T., Erickson, A.L., Ludwig, K.A., Reddy, C.M. & Lubchenco, J. 2017. Designing a solution to enable agency-academic scientific collaboration for disasters. *Ecology and Society,* 22(2):18.

Mehra, S. & Ranganathan, S. 2008. Implementing total quality management with a focus on enhancing customer satisfaction. *International Journal of Quality & Reliability Management*, 25(9):913-927.

Mele, C., Pels, J. & Polese, F. 2010. A brief review of systems theories and their managerial applications. *Service Science*, 2(1-2):126-135.

Mena, C., Adenso-Diaz, B. & Yurt, O. 2011. The causes of food waste in the supplier-retailer interface: Evidences from the UK and Spain. *Resources, Conservation and Recycling*, 55(6):648-658.

Mercier, S., Villeneuve, S., Mondor, M. & Uysal, I. 2017. Time–temperature management along the food cold chain: A review of recent developments. *Comprehensive Reviews in Food Science and Food Safety*, 16(4):647-667.

Meyer, S., Gibson, B. & Ward, P. 2015. Niklas Luhmann: Social Systems Theory and the Translation of Public Health Research. In: Collyer, F. (eds.) *The Palgrave Handbook of Social Theory in Health, Illness and Medicine*. London, UK: Palgrave Macmillan.

Michalec, A., Fodor, M., Hayes, E. & Longhurst, J. 2018. Co-designing food waste services in the catering sector. *British Food Journal*, 120(12):2762-2777.

Miller, J.G. & Miller, J.L. 1995. Applications of living systems theory. *Systems Practice*, 8(1):19-45.

Mockler, R.J. 1968. The systems approach to business organisation and decision-making. *California Management Review*, 11(2):53-58.

Modgil, S. & Sharma, S. 2016. Total productive maintenance, total quality management and operational performance. *Journal of Quality in Maintenance Engineering*, 22(4):353-377.

Moecke, E.H.S., Feller, R., Dos Santos, H.A., De Medeiros Machado, M., Cubas, A.L.V., De Aguiar Dutra, A.R., Santos, L.L.V. & Soares, S.R. 2016. Biodiesel production from waste cooking oil for use as fuel in artisanal fishing boats: Integrating environmental, economic and social aspects. *Journal of Cleaner Production*, 135: 679-688.

Moraes, N.V., Lermen, F.H. & Echeveste, M.E.S. 2021. A systematic literature review on food waste/loss prevention and minimization methods. *Journal of Environmental Management*, 286:112268.

Morath, C. & Doluschitz, R. 2009. Total Quality Management in the food industry – Current situation and potential in Germany. *APSTRACT: Applied Studies in Agribusiness and Commerce*, 4(3-4):83-87.

Morawicki, R.O. & González, D.J.D. 2018. Focus: Nutrition and Food Science: Food Sustainability in the Context of Human Behavior. *The Yale Journal of Biology and Medicine*, 91(2):191.

Morgado, F.F., Meireles, J.F., Neves, C.M., Amaral, A. & Ferreira, M.E. 2017. Scale development: ten main limitations and recommendations to improve future research practices. *Psicologia: Reflexão e Crítica*, 30(3):1-20.

Morgan, A.J., Chittleborough, P. & Jorm, A.F. 2016. Self-help strategies for sub-threshold anxiety: A Delphi consensus study to find messages suitable for population-wide promotion. *Journal of Affective Disorders*, 206:68-76.

Morgan, D.L. 2014. Pragmatism as a paradigm for social research. *Qualitative Inquiry*, 20(8):1045-1053.

Mosadeghrad, A.M. 2014. Essentials of total quality management: a meta-analysis. *International Journal of Health Care Quality Assurance*, 27(6):544-558.

Mosadeghrad, A.M. 2015. Developing and validating a total quality management model for healthcare organisations. *The TQM Journal*, 27(5):544-564

Mourad, M. 2016. Recycling, recovering and preventing 'food waste': competing solutions for food systems sustainability in the United States and France. *Journal of Cleaner Production*, 126:461-477.

Munizu, M. 2013. Total Quality Management (TQM) Practices toward product quality performance: Case at food and beverage industry in Makassar, Indonesia. *IOSR Journal of Business and Management (IOSR-JBM)*, 9(2):55-61.

Munro, N., Quayle, M., Simpson, H. & Barnsley, S. 2013. Hunger for knowledge: Food insecurity among students at the University of KwaZulu-Natal. *Perspectives in Education*, *31*(4):168-179.

Musa, H.D., Yacob, M.R., Abdullah, A.M. & Ishak, M.Y. 2015. Delphi method of developing environmental well-being indicators for the evaluation of urban sustainability in Malaysia. *Procedia Environmental Sciences*, 30:244-249.

Muturi, D., Ho, S., Douglas, A., Nawelwa, J., Sichinsambwe, C. & Mwanza, B. G. 2015. An analysis of total quality management (TQM) practices in Zambian secondary schools. *The TQM Journal*, 27(6):716-731.

Muzanechita, R. 2019. *Food services*. [Online] Available from: https://www.up.ac.za/student-accommodation/article/256299/food-services [Accessed: 2019-01-19].

Nahman, A. & De Lange, W. 2013. Costs of food waste along the value chain: Evidence from South Africa. *Waste Management*, 33(11):2493-2500.

Nahman, A., De Lange, W., Oelofse, S. & Godfrey, L. 2012. The costs of household food waste in South Africa. *Waste Management*, 32(11):2147-2153.

Nair, G.K. & Choudhary, N. 2016. Influence of critical success factors of total quality management on financial and non-financial performance of hospitality industry: an empirical study. *International Journal of Productivity and Quality Management*, 17(4):409-436.

Namkung, Y. & Jang, S.S. 2013. Effects of restaurant green practices on brand equity formation: do green practices really matter? *International Journal of Hospitality Management*, 33:85-95.

National Restaurant Association. 2018. *The state of restaurant sustainability*. [Online] Available from: https://restaurant.org/downloads/pdfs/sustainability/restaurant_sustainability_research_report_2018.pdf [Accessed: 2019-02-08].

Nawelwa, J., Sichinsambwe, C. & Mwanza, B.G. 2015. An analysis of total quality management TQM practices in Zambian secondary schools: A survey of Lusaka district. *The TQM Journal*, 27(6):716-731.

Nicolay, C.R., Purkayastha, S., Greenhalgh, A., Benn, J., Chaturvedi, S., Phillips, N. & Darzi, A. 2012. Systematic review of the application of quality improvement methodologies from the manufacturing industry to surgical healthcare. *British Journal of Surgery*, 99(3):324-335.

Niggli, U. 2014. Sustainability of organic food production: Challenges and innovations. *Proceedings of the Nutrition Society*, 74(1):83-88.

Notten, P., Bole-Rentel, T. & Rambaran, N. 2014. *Developing an understanding of the energy implications of wasted food and waste disposal*. [Online] Available from: http://www.fewlbnexus.uct.ac.za/sites/default/files/image_tool/images/91/2__a16245_developing_an_understanding_of_the_energy_implications_of_wasted_food_lores.pdf [Accessed: 2015-12-11].

Nozue, M., Yoshita, K., Jun, K., Ishihara, Y., Taketa, Y., Naruse, A., Nagai, N. & Ishida, H. 2010. Amounts served and consumed of school lunch differed by gender in Japanese elementary schools. *Nutrition Research and Practice*, *4*(5):400-404.

O'Leary, Z. 2014.*The essential guide to doing your research project*. 2nd ed. London, UK: SAGE.

O'Reilly, M. & Parker, N. 2012. 'Unsatisfactory Saturation': a critical exploration of the notion of saturated sample sizes in qualitative research. *Qualitative Research*, 13(2):190-197.

Oberascher, C., Stamminger, R. & Pakula, C. 2011. Energy efficiency in daily food preparation. *International Journal of Consumer Studies*, 35(2):201-211.

Oelofse, S.H. & Marx Pienaar, N.J.M.M. 2016. *Household food wastage — A case study of middle to high income urban households in the City of Tshwane*. Paper presented at 23rd WasteCon 2016, Johannesburg, South Africa, 17-21 October 2016: 51-56. [Online] Available from: http://researchspace.csir.co.za/dspace/handle/10204/8969 [Accessed: 2017-09-09].

Oelofse, S.H. & Nahman, A. 2013. Estimating the magnitude of food waste generated in South Africa. *Waste Management & Research*, 31(1):80-86.

Oelofse, S.H, Muswema, A. & Ramukhwatho, F. 2018. Household food waste disposal in South Africa: A case study of Johannesburg and Ekurhuleni. *South African Journal of Science*, 114(5-6):1-6.

Ofei, K.T., Holst, M., Rasmussen, H.H. & Mikkelsen, B.E. 2014. How practice contributes to trolley food waste. A qualitative study among staff involved in serving meals to hospital patients. *Appetite*, 83:49-56.

Ogden, S.R., Culp Jr, W.C., Villamaria, F.J. & Ball, T.R. 2016. Developing a checklist: consensus via a modified Delphi technique. *Journal of Cardiothoracic and Vascular Anaesthesia*, 30(4):855-858.

Okumus, B. 2020. How do hotels manage food waste? Evidence from hotels in Orlando, Florida. *Journal of Hospitality Marketing & Management*, 29(3):291-309.

Okumus, B., Taheri, B., Giritlioglu, I. & Gannon, M.J. 2020. Tackling food waste in all-inclusive resort hotels. *International Journal of Hospitality Management*, 88:1-10.

Ostenso, G.L., Moy, W.A. & Donaldson, B. 1965. Developing a generalized cafeteria simulator. *Journal of the American Dietetic Association*, 46:379-383.

Owen, S. 2001. The practical, methodological and ethical dilemmas of conducting focus groups with vulnerable clients. *Journal of Advanced Nursing*, 36(5):652-658.

Ozcicek-Dolekoglu, C. & Var, I. 2019. Analysis of food waste in university dining halls: a case study from Turkey. *Feb - Fresenius Environmental Bulletin*, 28:156-166.

Painter, K., Thondhlana, G. & Kua, H.W. 2016. Food waste generation and potential interventions at Rhodes University, South Africa. *Waste Management*, 56:491-497.

Pansiri, J. 2006. Doing tourism research using the pragmatism paradigm: an empirical example. *Tourism and Hospitality Planning & Development*, 3(3):223-240.

Papargyropoulou, E., Lozano, R., Steinberger, J.K., Wright, N. & Bin Ujang, Z. 2014. The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production*, 76:106-115.

Papargyropoulou, E., Wright, N., Lozano, R., Steinberger, J., Padfield, R. & Bin Ujang, Z. 2016. Conceptual framework for the study of food waste generation and prevention in the hospitality sector. *Waste Management*, 49:326-336.

Parfitt, J., Barthel, M. & Macnaughton, S. 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554):3065-3081.

Parizeau, K., Von Massow, M. & Martin, R. 2015. Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. *Waste Management*, 35:207-217.

Patiar, A., Davidson, M.C. & Wang, Y. 2012. Competition, total quality management practices, and performance: evidence from upscale hotels. *Tourism Analysis*, 17(2):195-211.

Payne-Palacio, J. & Theis, M. 2016. *Foodservice Management*: principles and practices. 13th ed. Harlow, UK: Pearson Education.

Pearson, D., Henryks, J. & Jones, H. 2011. Organic food: What we know and do not know about consumers. *Renewable Agriculture and Food Systems*, 26(2):171-177.

Peregrin, T. 2011. Sustainability in foodservice operations: An update. *Journal of the American Dietetic Association*, 111(9):1294.

Perramon, J., Del Mar Alonso-Almeida, M., Llach, J. & Bagur-Femenías, L. 2014. Green practices in restaurants: Impact on firm performance. *Operations Management Research*, *7*(1-2):2-12.

Petersen, P. B. 1999. Total quality management and the Deming approach to quality management. *Journal of Management History*, 5(8):468-488.

Pham, T.P.T., Kaushik, R., Parshetti, G.K., Mahmood, R. & Balasubramanian, R. 2015. Food waste-to-energy conversion technologies: current status and future directions. *Waste Management*, 38:399-408.

Phimolsiripol, Y., Siripatrawan, U., Tulyathan, V. & Cleland, D.J. 2008. Effects of freezing and temperature fluctuations during frozen storage on frozen dough and bread quality. *Journal of Food Engineering*, 84(1):48-56.

Pinard, C.A., Byker, C., Serrano, E. & Harmon, A. H. 2014. National chain restaurant practices supporting food sustainability. *Journal of Hunger & Environmental Nutrition*, 9(4):535-545.

Pinto, R.S., Dos Santos Pinto, R.M., Melo, F.F.S., Campos, S.S. & Cordovil, C.M.D. S. 2018. A simple awareness campaign to promote food waste reduction in a University canteen. *Waste Management*, 76:28-38.

Pirani, S.I. & Arafat, H.A. 2014. Solid waste management in the hospitality industry: A review. *Journal of Environmental Management*, 146:320-336.

Pirani, S.I. & Arafat, H.A. 2016. Reduction of food waste generation in the hospitality industry. *Journal of Cleaner Production*, 132:129-145.

Powell, T.C. 1995. Total quality management as competitive advantage: a review and empirical study. *Strategic Management Journal*, 16(1):15-37.

Prajogo, D.I. & McDermott, C.M. 2005. The relationship between total quality management practices and organizational culture. *International Journal of Operations & Production Management*, 25(11):1101-1122.

Prajogo, D.I. & Sohal, A.S. 2003. The relationship between TQM practices, quality performance, and innovation performance: An empirical examination. *International Journal of Quality & Reliability Management*, 20(8):901-918.

Prajogo, D.I. & Sohal, A.S. 2004. Transitioning from total quality management to total innovation management: an Australian case. *International Journal of Quality & Reliability Management*, 21(8):861-875.

Prasad, M.M., Dhiyaneswari, J.M., Jamaan, J.R., Mythreyan, S., & Sutharsan, S. M. 2020. A framework for lean manufacturing implementation in Indian textile industry. *Materials Today: Proceedings*, 33:2986-2995.

Prescott, M.P., Herritt, C., Bunning, M. & Cunningham-Sabo, L. 2019. Resources, Barriers, and Tradeoffs: A Mixed Methods Analysis of School Pre-Consumer Food Waste. *Journal of the Academy of Nutrition and Dietetics,* 119(8):1270-1283.

Priefer, C., Jörissen, J. & Bräutigam, K.R. 2016. Food waste prevention in Europe–A cause-driven approach to identify the most relevant leverage points for action. *Resources, Conservation and Recycling*, 109:155-165.

Psomas, E.L. & Fotopoulos, C.V. 2010. Total quality management practices and results in food companies. *International Journal of Productivity and Performance Management*, 59(7):668-687.

Psomas, E.L. & Jaca, C. 2016. The impact of total quality management on service company performance: evidence from Spain. *International Journal of Quality & Reliability Management*, 33(3):380-398.

Psomas, E., Vouzas, F., Bouranta, N. & Tasiou, M. 2017. Effects of total quality management in local authorities. *International Journal of Quality and Service Sciences*, 9(1):41-66.

Psomas, E., Vouzas, F. & Kafetzopoulos, D. 2014. Quality management benefits through the "soft" and "hard" aspect of TQM in food companies. *The TQM Journal,* 26(5):431-444.

Puckett, R.P., Connell, B.C., Dahl, M.K., Jackson, R. & McClusky, K.W. 2005. Practice paper of the American Dietetic Association: A systems approach to measuring productivity in health care foodservice operations. *Journal of the American Dietetic Association*, 105(1):122-130.

Qasrawi, B.T., Almahamid, S.M. & Qasrawi, S.T. 2017. The impact of TQM practices and KM processes on organisational performance: An empirical investigation. *International Journal of Quality & Reliability Management*, 34(7):1034-1055.

Quazi, H.A., Hong, C.W. & Meng, C.T. 2002. Impact of ISO 9000 certification on quality management practices: A comparative study. *Total Quality Management*, 13(1):53-67.

Quested, T.E., Marsh, E., Stunell, D. & Parry, A.D. 2013. Spaghetti soup: The complex world of food waste behaviours. *Resources, Conservation and Recycling*, 79:43-51.

Rahman, S.U. 2001. Total quality management practices and business outcome: Evidence from small and medium enterprises in Western Australia. *Total Quality Management*, 12(2):201-210.

Rajan, J., Fredeen, A.L., Booth, A.L. & Watson, M. 2018. Measuring food waste and creating diversion opportunities at Canada's Green University. *Journal of Hunger & Environmental Nutrition*, 13(4):573-586.

Ramosaj, B. & Berisha, G. 2014. Systems Theory and Systems Approach to Leadership. *Iliria International Review.* 4(1):59-76.

Ramukhwatho, F.R., Du Plessis, R. & Oelofse, S.H. 2014. *Household food wastage in a developing country: A case study of Mamelodi Township in South Africa*. Paper presented at 20th WasteCon Conference, Cape Town, South Africa, 6-10 October 2014: 468-475. [Online] Available from: http://researchspace.csir.co.za/dspace/bitstream/handle/10204/7757/Oelofse_2014.pdf?sequence=1&isAllowed=y [Accessed: 2016-03-04].

Ramukhwatho, F., Du Plessis, R. & Oelofse, S.H. 2018. Preliminary drivers associated with household food waste generation in South Africa. *Applied Environmental Education & Communication*, 17(3):254-265.

Rawlins, R. A. 2008. *Total Quality Management*. Avebury Bouveland, UK: AuthorHouse.

Reisch, L., Eberle, U. & Lorek, S. 2013. Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability: Science, Practice and Policy*, 9(2):7-25.

Ren, Y., Yu, M., Wu, C., Wang, Q., Gao, M., Huang, Q. & Liu, Y. 2018. A comprehensive review on food waste anaerobic digestion: Research updates and tendencies. *Bioresource Technology*, 247:1069-1076.

Rethink Food Waste (ReFED). 2017. *Foodservice food waste action guide*. [Online] Available from https://www.refed.com/downloads/Foodservice_Guide_Web.pdf [Accessed: 2018-09-11].

Richardson, T. 1997. *Total quality management.* New York, NY: Delmar Publishing.

Ringel, L., Hiller, P. & Zietsma, C. 2018. *Toward Permeable Boundaries of Organisations*? West Yorkshire, UK: Emerald Publishing Limited.

Risku-Norja, H. & Muukka, E. 2013. Food and sustainability: local and organic food in Finnish food policy and in institutional kitchens. *Acta Agriculturae Scandinavica, Section B – Soil & Plant Science*, 63(sup1):8-18.

Rodgers, S. 2005. Selecting a food service system: a review. *International Journal of Contemporary Hospitality Management*, 17(2):147-156.

Rodriguez-Martinez, V., Velazquez, G., Massa-Barrera, S., Welti-Chanes, J., Fagotti, F. & Torres, J.A. 2019. Estimation of safety and quality losses of foods stored in residential refrigerators. *Food Engineering Reviews*, 11(3):184-199.

Roller, M.R. & Lavrakas, P.J. 2015. *Applied qualitative research design: a total quality framework approach*. New York, NY: Guilford Publications.

Ross, P., Kemerer, S. & Taylor, L. 2006. Food safety in the workplace: A practical approach. *AAOHN Journal*, 54(12):521-530

Rostami, R., Naddafi, K., Arfaeinia, H., Nazmara, S., Fazlzadeh, M. & Saranjam, B. 2020. The effects of ventilation and building characteristics on indoor air quality in waterpipe cafés. *Journal of Exposure Science & Environmental Epidemiology*, 30(5):805-813.

Rousseau, D. 2015. General systems theory: Its present and potential. *Systems Research and Behavioral Science*, 32(5):522-533.

Rowley, J. 2012. Conducting research interviews. *Management Research Review*, 35(3/4):260-271.

Sabate, J. & Soret, S. 2014. Sustainability of plant-based diets: back to the future. *The American Journal of Clinical Nutrition*, 100(suppl_1): 476S-482S.

Saccares, S., Scognamiglio, U., Moroni, C., Marani, A., Calcaterra, V., Amendola, M. & Morena, V. 2014. Evaluation model of plate waste to monitor food consumption in two different catering settings. *Italian Journal of Food Safety*, 3(1669):107-110.

Sadikoglu, E. & Olcay, H. 2014. The effects of total quality management practices on performance and the reasons of and the barriers to TQM practices in Turkey. *Advances in Decision Sciences*, 1-17.

Sadikoglu, E. & Zehir, C. 2010. Investigating the effects of innovation and employee performance on the relationship between total quality management practices and firm performance: An empirical study of Turkish firms. *International Journal of Production Economics*, 127*(*1):13-26.

Sadri, R., Taheri, P., Azarsa, P. & Ghavam, H. 2011. Improving productivity through mistake-proofing of construction processes. In *2011 International Conference on Intelligent Building and Management,* 5:280-284.

Sakaguchi, L., Pak, N. & Potts, M.D. 2018. Tackling the issue of food waste in restaurants: Options for measurement method, reduction and behavioral change. *Journal of Cleaner Production*, 180:430-436.

Salemdeeb, R., Zu Ermgassen, E.K., Kim, M.H., Balmford, A. & Al-Tabbaa, A. 2017. Environmental and health impacts of using food waste as animal feed: a comparative analysis of food waste management options. *Journal of Cleaner Production*, 140:871-880.

Samat, N., Ramayah, T. & Mat Saad, N. 2006. TQM practices, service quality, and market orientation: Some empirical evidence from a developing country. *Management Research News*, 29(11):713-728.

Samson, D. & Terziovski, M. 1999. The relationship between total quality management practices and operational performance. *Journal of Operations Management*, 17(4):393-409.

Scales, B.J. 2013. Qualitative analysis of student assignments: A practical look at ATLAS.ti. *Reference Services Review*. [Online] Available from: https://www.emerald.com/insight/content/doi/10.1108/00907321311300956/full/html [Accessed: 2019-04-01].

Scholz, K., Eriksson, M. & Strid, I. 2015. Carbon footprint of supermarket food waste. *Resources, Conservation and Recycling*, 94*:*56-65.

Schubert, F. 2008. *Exploring and predicting consumers' attitudes and behaviours towards green restaurants.* Unpublished Masters dissertation. Ohio: The Ohio State University. [Online] Available from OhioLink:

https://etd.ohiolink.edu/apexprod/rws_olink/r/1501/10?clear=10&p10_accession_num=osu1216261814 [Accessed: 2016-08-12].

Schubert, F., Kandampully, J., Solnet, D. & Kralj, A. 2010. Exploring consumer perceptions of green restaurants in the US. *Tourism and Hospitality Research*, 10(4):286-300.

Schwartz, M.B., Henderson, K.E., Read, M., Danna, N. & Ickovics, J. R. 2015. New school meal regulations increase fruit consumption and do not increase total plate waste. *Childhood Obesity*, 11(3):242-247.

Scotland Resource Efficient. 2014. *Managing food waste in the hospitality and food service industry.* [Online] Available from: https://www.olleco.co.uk/docs/default-source/downloads/managing-food-waste-in-the-hospitality-amp-food-service-industry-doc.pdf?sfvrsn=2 [Accessed: 2015-11-13].

Scott, C. & Medaugh, M. 2017. Axial Coding. *The International Encyclopedia of Communication Research Methods*, 1-2.

Seising, R. 2010. Cybernetics, system(s) theory, information theory and fuzzy sets and systems in the 1950s and 1960s. *Information Sciences*, 180(23):4459-4476.

Sellahewa, J.N. & Martindale, W. 2010. The impact of food processing on the sustainability of the food supply chain. *Delivering food security with supply chain led innovations: understanding supply chains, providing food security, delivering choice, Royal Holloway, Egham, UK*, 7-9.

Seyfang, G. 2006. Ecological citizenship and sustainable consumption: Examining local organic food networks. *Journal of Rural Studies*, 22(4):383-395.

Shaffer J.G. 1979. Job design in conventional and highly technical hospital food service systems. Unpublished Masters dissertation. Manhattan: Kansas State University. Available from:https://krex.kstate.edu/dspace/bitstream/handle/2097/27178/LD2668T41979S52.pdf?sequence=1 [Accessed: 2017-06-07].

Sharkey, S.B. & Sharples, A.Y. 2001. An approach to consensus building using the Delphi technique: developing a learning resource in mental health. *Nurse Education Today*, 21(5):398-408.

Shepherd, R., Magnusson, M. & Sjödén, P.O. 2005. Determinants of consumer behavior related to organic foods. *AMBIO: A Journal of the Human Environment*, 34(4):352-360.

Shokri, A., Oglethorpe, D. & Nabhani, F. 2014. Evaluating sustainability in the UK fast food supply chain: Review of dimensions, awareness and practice. *Journal of Manufacturing Technology Management*, 25(8):1224-1244.

Siegel, R., Antony, J., Garza-Reyes, J. A., Cherrafi, A. & Lameijer, B. 2019. Integrated green lean approach and sustainability for SMEs: From literature review to a conceptual framework. *Journal of Cleaner Production*, 240:1-14.

Sila, I. & Ebrahimpour, M. 2004. An examination of quality management in luxury hotels. *International Journal of Hospitality & Tourism Administration*, *4*(2):33-59.

Silvennoinen, K., Heikkilä, L., Katajajuuri, J. M. & Reinikainen, A. 2015. Food waste volume and origin: Case studies in the Finnish food service sector. *Waste Management*, 46:140-145.

Singh, R. 2015. Empirical examination of the impact of total quality services on hospitality industry business. *Journal of Quality Assurance in Hospitality & Tourism*, 16(4):389-413.

Smit, B. 2002. Atlas.ti for qualitative data analysis. *Perspectives in Education*, 20(3):65-75.

Smith-Spangler, C., Brandeau, M.L., Hunter, G.E., Bavinger, J.C., Pearson, M., Eschbach, P.J. & Olkin, I. 2012. Are organic foods safer or healthier than conventional alternatives?: a systematic review. *Annals of Internal Medicine*, 157(5):348-366.

Smith, K.S. & Simpson, R.D. 1995. Validating teaching competencies for faculty members in higher education: a national study using the Delphi method. *Innovative Higher Education*, 19(3):223-234.

Smith, N.J. & Sage, A.P. 1973. An introduction to hierarchical systems theory. *Computers & Electrical Engineering*, 1(1):55-71.

Smith, S.L. & Cunningham-Sabo, L. 2014. Food choice, plate waste and nutrient intake of elementary-and middle-school students participating in the US National School Lunch Program. *Public Health Nutrition*, 17(6):1255-1263.

Soklaridis, S. 2009. The process of conducting qualitative grounded theory research for a doctoral thesis: Experiences and reflections. *The Qualitative Report*, 14(4):718-733.

Soltani, E. & Wilkinson, A. 2020. TQM and performance appraisal: complementary or incompatible?. *European Management Review*, 17(1):57-82.

Someh, I.A. & Shanks, G. 2015. *How business analytics systems provide benefits and contribute to firm performance?.* [Online] Available from: https://aisel.aisnet.org/ecis2015_cr/12 [Accessed: 2016-11-13].

Sonnino, R. & McWilliam, S. 2011. Food waste, catering practices and public procurement: A case study of hospital food systems in Wales. *Food Policy*, 36(6):823-829.

Sossa, J.W.Z., Halal, W. & Zarta, R.H. 2019. Delphi method: analysis of rounds, stakeholder and statistical indicators. *Foresight*, 21(5):525-544.

Spears, M.C. & Vaden, A.G. 1985. *Foodservice organisations: a managerial and systems approach*. New York, USA: Collier Macmillan Canada.

Stagl, S. 2002. Local organic food markets: potentials and limitations for contributing to sustainable development. *Empirica*, 29(2):145-162.

Statistics South Africa. 2017. *Higher education and skills in South Africa, 2017.* [Online] Available from: http://www.statssa.gov.za/publications/Report-92-01-05/Report-92-01-052017.pdf [Accessed: 2019-08-30].

Stephens, N. 2007. Collecting data from elites and ultra-elites: telephone and face-to-face interviews with macroeconomists. *Qualitative Research*, 7(2):203-216.

Stewart, D.W. & Shamdasani, P. N. 2015. *Focus groups: theory and practice.* 3rd ed. Thousand Oaks, CA: SAGE.

Stewart, J. & Ayres, R. 2001. Systems theory and policy practice: An exploration. *Policy Sciences*, 34(1):79-94.

Stoddard, J.E., Pollard, C.E. & Evans, M.R. 2012. The triple bottom line: A framework for sustainable tourism development. *International Journal of Hospitality & Tourism Administration*, 13(3):233-258.

Strotmann, C., Göbel, C., Friedrich, S., Kreyenschmidt, J., Ritter, G. & Teitscheid, P. 2017. A participatory approach to minimizing food waste in the food industry — A manual for managers. *Sustainability*, 9(1):66.

Sullivan, C.F. & Atlas, C. 1998. *Health care food service systems management*. Maryland, MD: Jones & Bartlett Learning.

Sureshchandar, G.S., Rajendran, C. & Anantharaman, R.N. 2001. A conceptual model for total quality management in service organizations. *Total Quality Management*, 12(3):343-363.

Taha, S., Osaili, T.M., Saddal, N.K., Al-Nabulsi, A.A., Ayyash, M.M. & Obaid, R.S. 2020. Food safety knowledge among food handlers in food service establishments in United Arab Emirates. *Food Control*, 110:1-8.

Talib, H.H.A., Ali, K.A.M. & Idris, F. 2013. Quality management framework for the SME's food processing industry in Malaysia. *International Food Research Journal*, *20*(1).

Talib, F., Rahman, Z. & Qureshi, M.N. 2011. Prioritising the practices of total quality management: An analytic hierarchy process analysis for the service industries. *Total Quality Management & Business Excellence*, *22*(12):1331-1351.

Talib, F., Rahman, Z. & Qureshi, M.N. 2012. Total quality management practices in Indian hospitality industry: some key findings from survey. In *Proceedings of National Conference on Emerging Challenges for Sustainable Business (ECSB-2012), Indian Institute of Technology Roorkee. Roorkee,* 1(2):1866-1888.

Talib, F., Rahman, Z. & Qureshi, M.N. 2013. An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies. *International Journal of Quality & Reliability Management*, 30(3):280-318.

Tarí, J.J. 2005. Components of successful total quality management. *The TQM Magazine*, 17(2):182-194.

Tarí, J.J., Molina, J.F. & Castejon, J.L. 2007. The relationship between quality management practices and their effects on quality outcomes. *European Journal of Operational Research*, 183(2):483-501.

Temtime, Z.T. 2003. The moderating impacts of business planning and firm size on total quality management practices. *The TQM Magazine,* 15(1):52-60.

Thangaratinam, S. & Redman, C.W. 2005. The delphi technique. *The Obstetrician & Gynaecologist*, 7(2):120-125.

Theodorakioglou, Y., Gotzamani, K. & Tsiolvas, G. 2006. Supplier management and its relationship to buyers' quality management. *Supply Chain Management: An International Journal*, 11(2):148-159.

Thi, N.B.D., Kumar, G. & Lin, C.Y. 2015. An overview of food waste management in developing countries: Current status and future perspective. *Journal of Environmental Management*, 157:220-229.

Thiagarajah, K. & Getty, V.M. 2013. Impact on plate waste of switching from a tray to a trayless delivery system in a university dining hall and employee response to the switch. *Journal of the Academy of Nutrition and Dietetics*, 113(1):141-145.

Thorsen, A.V., Lassen, A.D., Andersen, E.W., Christensen, L.M., Biltoft-Jensen, A., Andersen, R. & Tetens, I. 2015. Plate waste and intake of school lunch based on the new Nordic diet and on packed lunches: a randomised controlled trial in 8-to 11-year-old Danish children. *Journal of Nutritional Science*, 4:20.

Thyberg, K.L. & Tonjes, D.J. 2016. Drivers of food waste and their implications for sustainable policy development. *Resources, Conservation and Recycling*, 106:110-123.

Tilman, D. & Clark, M. 2014. Global diets link environmental sustainability and human health. *Nature*, 515:518-522.

Topalović, S. 2015. The implementation of total quality management in order to improve production performance and enhancing the level of customer satisfaction. *Procedia Technology*, 19:1016-1022.

Treharne, G.J. & Riggs, D.W. 2014. Ensuring quality in qualitative research. *Qualitative research in clinical and health psychology*, 57-73.

Truong, T.T., Yap, M.H. & Ineson, E.M. 2012. Potential Vietnamese consumers' perceptions of organic foods. *British Food Journal*, 114(4):529-543.

Tsang, J.H.Y. & Antony, J. 2001. Total quality management in UK service organisations: some key findings from a survey. *Managing Service Quality: An International Journal*, 11(2):132-141.

Turner, C.E. 2013. Mixed Methods Research. *The companion to language assessment*, 3:1403-1417.

Tynan, C.A., & Drayton, J.L. 1988. Conducting focus groups — a guide for first-time users. *Marketing Intelligence & Planning*, 6(1):5-9.

Ugboro, I.O. & Obeng, K. 2000. Top management leadership, employee empowerment, job satisfaction, and customer satisfaction in TQM organizations: an empirical study. *Journal of Quality Management*, 5(2):247-272.

Umaña-Taylor, A.J. & Bámaca, M.Y. 2004. Conducting focus groups with Latino populations: Lessons from the field. *Family Relations*, 53(3):261-272.

United Nations. 2019. *Sustainable Development Goals*. [Online] Available from: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ [Accessed: 2019-05-02].

United States Environmental Protection Agency. 2014. *Reducing wasted food & packaging: A guide for food services and restaurants.* [Online] Available from: https://www.epa.gov/sites/production/files/2015-09/documents/toolkt_training.pdf [Accessed: 2015-06-09].

Universities South Africa. 2021. *Public universities in South Africa*. [Online] Available from https://www.usaf.ac.za/public-universities-in-south-africa/ [Accessed: 2021-04-04].

University of Pretoria. 2019. *Campuses, maps & directions.* [Online] Available from: http://www.up.ac.za/article/2749435/campuses-maps-directions [Accessed: 2019-01-12].

University of Pretoria. 2019. *Registration process going smoothly at UP*. [Online] Available from: https://www.up.ac.za/news/post_2744167-registration-process-going-smoothly-at-up [Accessed: 2019-03-03].

University of Pretoria. 2014. *Tuks Monate dining hall.* [Online] Available from: https://www.facebook.com/UnivofPretoria/photos/a.675552465815905/675553149149170/?type=3&theater [Accessed: 2016-04-08].

Unklesbay, N.F., Maxcy, R.B., Knickrehm, M.E., Stevenson, K.E., Cremer, M.L. & Matthews, M.E. 1977. Foodservice systems: product flow and microbial quality and safety of foods. in: *Research Bulletin 1018*. University of Missouri-Columbia Agricultural Experiment Station, Columbia.

US Environmental Protection Agency. 2014. *Food recovery hierarchy*. [Online] Available from: https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy [Accessed: 2016-01-12].

Vaden, A.G. 1980. *A model for evaluating the foodservice system*. Manhattan, KS. Kansas State University.

Van Assen, M.F. 2018. The moderating effect of management behaviour for Lean and process improvement. *Operations Management Research*, 11(1):1-13.

Van den Berg, L. & Raubenheimer, J. (2015). Food insecurity among students at the University of the Free State, South Africa. *South African Journal of Clinical Nutrition*, 28(4):160-169.

Van der Westhuizen, E. 2015. Verbal communication with the researcher on 15 June. Pretoria. (Notes in possession of researcher).

Van Ewijk, S. & Stegemann, J.A. 2016. Limitations of the waste hierarchy for achieving absolute reductions in material throughput. *Journal of Cleaner Production*, 132:122-128.
Van Geffen, L., Van Herpen, E. & Van Trijp, H. 2020. Household food waste — How to avoid it? An integrative review. In *Food Waste Management.* Palgrave Macmillan: Cham.

Van Holsteijn, F. & Kemna, R. 2018. Minimizing food waste by improving storage conditions in household refrigeration. *Resources, Conservation and Recycling*, 128: 25-31.

Verghese, K., Lewis, H., Lockrey, S. & Williams, H. 2015. Packaging's role in minimizing food loss and waste across the supply chain. *Packaging Technology and Science*, 28(7):603-620.

Vibetti, S.P. 2012. *Development of a framework to assess the quality of production processes in South African public hospitals*. Unpublished doctoral thesis. Pretoria: Tshwane University of Technology. [Online] Available from: http://tutvital.tut.ac.za:8080/vital/access/manager/Repository/tut:2227 [Accessed: 2016-06-05].

Von Bertalanffy, L. 1972. The history and status of general systems theory. *Academy of Management Journal*, 15(4):407-426.

Von Massow, M. & McAdams, B. 2015. Table scraps: An evaluation of plate waste in restaurants. *Journal of foodservice business research*, 18(5):437-453.

Vu, H.M., Chan, H.K., Lim, M.K. & Chiu, A.S. 2017. Measuring business sustainability in food service operations: a case study in the fast food industry. *Benchmarking: An International Journal*, 24(4):037-1051.

Wang, C.H., Chen, K.Y., & Chen, S.C. 2012. Total quality management, market orientation and hotel performance: The moderating effects of external environmental factors. *International Journal of Hospitality Management*, 31(1):119-129.

Wang, R. 2012. Investigations of important and effective effects of green practices in restaurants. *Procedia — Social and Behavioral Sciences*, (40):94-98.

Wang, Y.F., Chen, S.P., Lee, Y.C. & Tsai, C.T.S. 2013. Developing green management standards for restaurants: An application of green supply chain management. *International Journal of Hospitality Management*, 34:263-273.

Waste and Resources Action Programme (WRAP). 2013. *Overview of waste in the UK hospitality and food service sector.* [Online] Available from: http://www.wrap.org.uk/sites/files/wrap/Overview%20of%20Waste%20in%20the%20UK%20Hospitality%20and%20Food%20Service%20Sector%20FINAL.pdf [Accessed: 2015-11-15].

Waste and Resources Action Programme (WRAP). 2019. *Action on food waste*. [Online] Available from https://wrap.org.uk/taking-action/food-drink/actions/action-on-food-waste [Accessed: 2019-12-12].

Weber, C.L. & Matthews, H.S. 2008. Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science & Technology,* 42(10):3508-3513.

Welikala, D. & Sohal, A.S. 2008. Total Quality Management and employees' involvement: A case study of an Australian organisation. *Total Quality Management*, 19(6):627-642.

Whitehair, K.J., Shanklin, C.W. & Brannon, L.A. 2013. Written messages improve edible food waste behaviors in a university dining facility. *Journal of the Academy of Nutrition and Dietetics*, 113(1):63-69.

Whittemore, R. & Knafl, K. 2005. The integrative review: updated methodology. *Journal of Advanced Nursing*, 52(5):546-553.

Williams, P. & Walton, K. 2011. Plate waste in hospitals and strategies for change. *e-SPEN, the European e-Journal of Clinical Nutrition and Metabolism*, 6(6):235-241.

Wilson, J. 2010. *Essentials of business research: a guide to doing your research project*. London: SAGE Publication.

Winter, C.K. & Davis, S.F. 2006. Organic foods. *Journal of Food Science*, 71(9):117-124.

Wong, L.P. 2008. Focus group discussion: a tool for health and medical research. *Singapore Medical Journal*, 49(3):256-60. [Online] Available from: https://umexpert.um.edu.my/file/publication/00007704_17969.pdf [Accessed: 2019-03-02].

Woods, M., Paulus, T., Atkins, D.P. & Macklin, R. 2016. Advancing qualitative research using qualitative data analysis software (QDAS)? Reviewing potential versus practice in published studies using ATLAS.ti and NVivo, 1994-2013. *Social Science Computer Review*, 34(5):597-617.

World-Wide Fund for Nature-South Africa. 2017. *The truth about our food waste problem*. [Online] Available from https://www.wwf.org.za/?21962/The-truth-about-our-food-waste-problem [Accessed: 2019-02-05].

Wu, Y., Tian, X., Li, X., Yuan, H. & Liu, G. 2019. Characteristics, influencing factors, and environmental effects of plate waste at university canteens in Beijing, China. *Resources, Conservation and Recycling*, 149:151-159.

Wunderlich, S.M. & Martinez, N.M. 2018. Conserving natural resources through food loss reduction: Production and consumption stages of the food supply chain. *International Soil and Water Conservation Research*, *6*(4):331-339.

Xu, F., Li, Y., Ge, X., Yang, L. & Li, Y. 2018. Anaerobic digestion of food waste – Challenges and opportunities. *Bioresource Technology*, 247:1047-1058.

Xu, Y. & Jeong, E. 2019. The effect of message framings and green practices on customers' attitudes and behavior intentions toward green restaurants. *International Journal of Contemporary Hospitality Management*, 31(6):2270-2296.

Yaseen, M.M., Sweis, R.J., Abdallah, A.B., Obeidat, B.Y. & Sweis, N.J. 2018. Benchmarking of TQM practices in the Jordanian pharmaceutical industry (a comparative study). *Benchmarking: An International Journal*, 25(9):4058-4083.

Yong, J. & Wilkinson, A. 2001. Rethinking total quality management. *Total Quality Management*, 12(2):247-258.

Yu, M. & Nagurney, A. 2013. Competitive food supply chain networks with application to fresh produce. *European Journal of Operational Research*, 224(2):273-282.

Yusof, N. M., Zahari, M.S.M., Abdullah, N., Ghani, F.A. & Abdullah, R.P.S.R. 2018. Cook-chilled food in Malaysia Primary Schools: What the school headmasters think? *International Journal of Academic Research in Business and Social Sciences*, *8*(17):113-122.

Zagorski, J., Reyes, G.A., Prescott, M.P. & Stasiewicz, M.J. 2020. Literature Review Investigating Intersections between US Foodservice Food Recovery and Safety. *Resources, Conservation and Recycling*, 168:1-9.

Zehir, C. & Sadikoglu, E. 2012. Relationships among Total Quality Management Practices: An Empirical Study in Turkish Industry. *International Journal of Performability Engineering*, *8*(6): 667-678.

Zhang, C., Su, H., Baeyens, J. & Tan, T. 2014. Reviewing the anaerobic digestion of food waste for biogas production. *Renewable and Sustainable Energy Reviews*, 38:383-392.

Zheng, T.M., Zhu, D., Kim, P.B. & Williamson, D. 2020. An Examination of the interaction effects of hospitality employees' motivational and cultural factors in the workplace. *International Journal of Hospitality & Tourism Administration*, 1-29.

Zhong, J., Ma, Y., Tu, Y. & Li, X. 2016. Supply chain quality management: an empirical study. *International Journal of Contemporary Hospitality Management*, 28(11):2446-2472.

Zijlstra, E. & Mobach, M. P. 2011. The influence of facility layout on operations explored. *Journal of Facilities Management*, 9(2):127-144.

ADDENDA A - S

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM A: REQUEST FOR ACCESS OF STUDY SITE

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Natural and Agricultural Sciences

Department of Consumer Sciences

Date: 28 June 2016

Director
Food Services Division
Department of Residence Affairs and Accommodation
University of Pretoria

REQUEST FOR ACCESS TO CONDUCT RESEARCH AT RESIDENTIAL FOOD SERVICE UNITS

My name is Boineelo Pearl Lefadola and I am a PhD student working under the supervisions of Dr Annemarie Viljoen and Dr Gerrie DuRand in the Department of Consumer Sciences at the University of Pretoria. I am undertaking a research study titled: *"Development of a Total Quality Management Tool Integrating Sustainability Practices to Address Food Waste: A Case Study in a University Food Service Unit".* Prior to undertaking the study, we wish to seek your permission to carry out the research at the university residential food service units.

In this study, we aim to develop, and validate a total quality management tool that integrates sustainability practices, in order to address food waste at residential food service units of the University of Pretoria. In order to collect data such methods as observations, face-to-face interviews, focus group discussions and analysis of organisational reports. Food service workers including food service managers and supervisors, front of the house staff and back of the house staff will directly be recruited to take part in the study. Permission from potential participants will be sought.

I guarantee total confidentiality of information. If I intend to use any information that is in any way sensitive, I will seek the permission of the originator before using it. There will be total confidentiality of all names and I will not mention the names of residential food service units without permission.

Sincerely,

B.P. Lefadola

Boineelo Pearl Lefadola (PhD Student & Principal Investigator)

Email: u13275004@tuks.co.za

ADDENDUM B: DOCUMENT ANALYSIS GUIDE

Date: ____

Title of source: ____

A: **Systems Components**	**B:** **Subsystem**	**C:** **TQM Practices**	**D:** **Sustainability Practices**	**E:** **Elements of Food Waste Generation and Reduction**
A1: Inputs	Food materials Human resources Facilities			
A2: Transformation	Procurement Receiving Storage & Inventory Control Production Holding Distribution Service			
A3: Controls	Plans Contracts Laws and Regulations			
A4: Management	Functions Linking processes			
A5: Memory	Financial Personnel Forecasting			
A6: Environmental factors				

ADDENDUM C: FACE-TO-FACE INTERVIEW GUIDE

Date: ………………………………………….

Start time: …………………………………………………..

Stop time: ……………………………………………………

Moderator: …………………………………………………..

Participant(s): ………

Venue (Describe the setting & mood)**:** ……………………………………………………………………………………

Introduction: Mention the purpose of the study. Set the right tone – the project is a positive collaborative process about getting good data and coming up with solutions.

1) What would say are the causes and drivers of food waste in the food service unit from procurement point up to service of meals?

2) What strategies are put in place to reduce food waste at different stages of the food service unit?

3) Clarify how easy or not easy is it to apply strategies drawn.

4) How does the unit manage leftovers as well as other types of FW? (discuss from point of FW management hierarchy)

5) What quality management practices do you have in place?

6) How do these QM practices reduce and or contribute to food waste generation?

7) Are there any sustainability practices in place? How do they contribute or lessen food waste generation?

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM D: FOCUS GROUP DISCUSSION GUIDE

Date: ______________________________

Start time:______________________________

Stop time: ______________________________

Moderator: ______________________________

Participants :______________________________

Venue: ______________________________

Introduction: Purpose of the study & setting the right tone

Focus Question	Responses	Key issues
1) What are your experiences with issues of food waste in the kitchen?		
2) What do you think are the practices that contribute to food waste?		
3) What strategies do you implement to cut on food waste?		
4) What quality management strategies do you put in place? How would you relate them to the issue of food waste?		
5) What sustainability practices do you follow? How do they influence food waste generation?		
Summary & Reflections		

ADDENDUM E: PARTICIPANT OBSERVATION GUIDE

Date: ______________________

Natural setting: ____

The people: ____

Individual actions:____

Group behaviours: ____

Personal impressions and feelings:____

A: **Systems Components**	**B:** **Subsystem**	**C:** **TQM Practices**	**D:** **Sustainability Practices**	**E:** **Elements of Food Waste Generation and Reduction**
A1: Inputs	Food materials Human resources Facilities			
A2:Transformation	Procurement Receiving Storage & Inventory Control Production Holding Distribution Service			
A3: Controls	Plans Contracts Laws and Regulations			
A4: Management	Functions Linking processes			
A5: Memory	Financial Personnel Forecasting			
A6: Environmental factors				

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM F: CONSENT FORM FOR SUBJECTS WILLING TO PARTICIPATE IN FACE-TO-FACE INTERVIEWS

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Natural and Agricultural Sciences

INFORMATION LEAFLET AND INFORMED CONSENT (FACE TO FACE INTERVIEWS) RESEARCH PROJECT ON DEVELOPMENT OF A TOTAL QUALITY MANAGEMENT TOOL INTEGRATING SUSTAINABILITY PRACTICES TO ADDRESS FOOD WASTE: A CASE IN A UNIVERSITY FOOD SERVICE UNIT.

Dear Participant

1) INTRODUCTION

We invite you to **volunteer** to participate in a **face-to-face interview** for the above titled research study. This information leaflet will help you to decide if you want to participate or not. Before you agree to take part you should fully understand what is involved. If you have any questions that this leaflet does not fully explain, please do not hesitate to ask the interviewer/ enumerator.

2) THE NATURE AND PURPOSE OF THIS STUDY

The purpose of this study is to develop, and validate a Total Quality Management tool that integrates sustainability practices, in order to address food waste at residential food service units of the University of Pretoria.

There is limited information about food waste in the context of university food service units. To be able to develop an appropriate and meaningful tool to address food waste, it is necessary to collect information on practices that may contribute to food waste. Information on quality management practices, sustainability practices and food waste management will be required.

3) EXPLANATION OF PROCEDURES TO BE FOLLOWED

As part of the face-to-face interviews the following will be involved:

1. Asking questions on your experiences with food waste generation in the food service unit, quality management practices in place, sustainability practices as well as food waste management issues and challenges faced regarding control of food waste.

2. With your permission I would like to audio record the interview and take notes for later analysis.

3. Face-to-face interviews will be carried out at four different phases of the research study; problem identification, situational analysis phase, implementation and evaluation phases.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

4) RISKS INVOLVED IN PARTICIPATING IN THE STUDY

There are **no risks** involved in participating in this study. All information obtained from you will be handled as **confidential**. The researcher will not reveal participants' responses to anyone other than co-researchers who have a significant role in the research investigation.

5) POSSIBLE BENEFITS OF THIS STUDY

Although you will not benefit directly from the study, the results of the study will enable the Department of Residence Affairs and Accommodation; Food Service Division to make strategic and tactical decisions on food waste management as well as provide useful information that will shape the University of Pretoria Food Waste Management Policy. Additionally, the intervention to be implemented in this study is aimed at reducing food waste therefore there is potential for improved food security, decreased pressure on resources required for food production, economic efficiency and reduction of the environmental burden.

6) WHAT ARE YOUR RIGHTS AS A PARTICIPANT?

Even though participation is encouraged, your participation in this study is entirely voluntary. You can refuse to participate or stop at any time during the study without giving any reason. Your withdrawal will not affect you or your work conditions in any way.

7) HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received written approval from the Research Ethics Committee of the Faculty of Natural and Agricultural Sciences at the University of Pretoria. A copy of the approval letter is available if you wish to have one.

8) COMPENSATION

Your participation is voluntary. No compensation towards your expenses will be given for your participation.

9) CONFIDENTIALITY

The information captured in this throughout the study is strictly confidential and will be used for research purposes at the University of Pretoria. Research reports and articles in scientific journals will not include any information that may identify individual participants.

11) QUESTIONS

The participant has been given the opportunity to ask questions regarding the proposed study. If there are any additional questions the researcher may be contacted at 082 424 4089 or email u13275004@tuks.co.za.

If you are happy to participate then please complete and sign the form below. Please initial the boxes below to confirm that you agree with each statement:

	Please Initial box:
I confirm that I have read and understood the information leaflet and have had the opportunity to ask questions.	

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. ☐

I understand that my responses will be kept strictly confidential. I understand that my name will not be linked with the research materials, and will not be identified or identifiable in the report or reports that result from the research. ☐

I agree for this interview to be tape-recorded. I understand that the audio recording made of this interview will be used only for analysis and that extracts from the interview, from which I would not be personally identified, may be used in any conference presentation, report or journal article developed as a result of the research. I understand that no other use will be made of the recording without my written permission, and that no one outside the research team will be allowed access to the original recording. ☐

I agree that my anonymised data will be kept for future research purposes such as publications related to this study after the completion of the study. ☐

I agree to take part in this interview. ☐

Please Initial box:

Participant's name ……... (Please print)

Participant's signature: ....…………………………Date...............................

Investigator's name ....…………………………………….... (Please print)

Investigator's signature ....………………………Date.….........................

Witness's Name ....………………... (Please print)

Witness's signature ....……………….............Date.…...............................

ADDENDUM G: CONSENT FORM FOR SUBJECTS WILLING TO PARTICIPATE IN FOCUS GROUP DISCUSSIONS

Faculty of Natural and Agricultural Sciences

INFORMATION LEAFLET AND INFORMED CONSENT (FOCUS GROUP DISCUSSION) RESEARCH PROJECT ON DEVELOPMENT OF A TOTAL QUALITY MANAGEMENT TOOL INTEGRATING SUSTAINABILITY PRACTICES TO ADDRESS FOOD WASTE: A CASE IN A UNIVERSITY FOOD SERVICE UNIT.

Dear Participant

1) INTRODUCTION

We invite you to **volunteer** to participate in a focus group discussion for a research study. This information leaflet will help you to decide if you want to participate or not. Before you agree to take part you should fully understand what is involved. If you have any questions that this leaflet does not fully explain, please do not hesitate to ask the interviewer/ enumerator.

2) THE NATURE AND PURPOSE OF THIS STUDY

The purpose of this study is to develop, and validate a Total Quality Management tool that integrates sustainability practices, in order to address food waste at residential food service units of the University of Pretoria.

There is limited information about food waste in the context of university food service units. To be able to develop an appropriate and meaningful tool to address food waste, it is necessary to collect information on practices that may contribute to food waste. Information on quality management practices, sustainability practices and food waste management will be required.

3) EXPLANATION OF PROCEDURES TO BE FOLLOWED

The focus group discussion part of the study will involve:

- In-depth discussion on food service workers' views, perceptions and experiences on food practices that may contribute to food waste, quality management practices in place, sustainability practices as well as food waste management issues.
- The discussion will be audio tape recorded if participants permit researchers to tape record.
- Researchers will take notes of what is being discussed.
- Focus group discussions will be carried out at three different phases of the research study; situational analysis phase, implementation and evaluation phases.

4) AUDIOTAPE PERMISSION

I have been told that the discussion will be tape recorded only if all participants agree.

I have been told that I can state that I don't want the discussion to be taped and it will not be. I can ask that the tape be turned off at any time.

I agree to be audio taped ___Yes ___No

5) RISKS INVOLVED IN PARTICIPATING IN THE STUDY

There are **no risks** involved in participating in this study. All information obtained from you will be handled as **confidential**. The researcher will not reveal participants' responses to anyone other than co-researchers who have a significant role in the research investigation.

6) POSSIBLE BENEFITS OF THIS STUDY

Although you will not benefit directly from the study, the results of the study will enable the Department of Residence Affairs and Accommodation; Food Service Division to make strategic and tactical decisions on food waste management as well as provide useful information that will shape the University of Pretoria Food Waste Management Policy. Additionally, the intervention to be implemented in this study is aimed at reducing food waste therefore there is potential for improved food security, decreased pressure on resources required for food production, economic efficiency and reduction of the environmental burden.

7) WHAT ARE YOUR RIGHTS AS A PARTICIPANT?

Even though participation is encouraged, your participation in this study is entirely voluntary. You can refuse to participate or stop at any time during the study without giving any reason. Your withdrawal will not affect you or your work conditions in any way.

8) HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received written approval from the Research Ethics Committee of the Faculty of Natural and Agricultural Sciences at the University of Pretoria. A copy of the approval letter is available if you wish to have one.

9) COMPENSATION

Your participation is voluntary. No compensation towards your expenses will be given for your participation.

10) CONFIDENTIALITY

The information captured in this throughout the study is strictly confidential and will be used for research purposes at the University of Pretoria. Research reports and articles in scientific journals will not include any information that may identify individual participants.

I confirm that the person asking my consent to take part in this study has told me about nature and process of the study. I have also received, read and understood the above written information (Information Leaflet and Informed Consent) regarding the study. I am aware that the results of the study will be anonymously processed into research reports. I am participating willingly. I have had time to ask questions and have no objection to participate in the study. I understand that there is no penalty should I wish to discontinue with the study.

11) QUESTIONS

Participants will be given the opportunity to ask questions regarding the proposed study. If there are any additional questions the researcher may be contacted at 082 424 4089 or email u13275004@tuks.co.za.

I have received a signed copy of this informed consent agreement.

Participant's name ……..…............ (Please print)

Participant's signature: ....………………………….Date............................

Investigator's name ....…………………………..................... (Please print)

Investigator's signature ....………………………..Date.….........................

Witness's Name ....…………….. (Please print)

Witness's signature ....…………………..............Date.….........................

VERBAL INFORMED CONSENT (If the respondent cannot read)

I, the undersigned, have read and have fully explained the participant information leaflet, which explains the nature and process of the study to the participant whom I have asked to participate in the study. The participant indicates that s/he understands that the results of the study will be anonymously processed into research reports. The participant indicates that s/he participating willingly. The participant indicates that s/he has had time to ask questions and has no objection to participate in the interview. S/he understands that there is no penalty should s/he wish to discontinue with the study. I hereby certify that the client has agreed to participate in this study.

Participant's Name ....……..........................(Please print)

Person seeking consent ....…..................................... (Please print)

Signature ....…………….............Date.......................................

Witness's name ....……………..…..................................... (Please print)

Signature ....…………………………Date.…...................................

ADDENDUM H: CONSENT FORM FOR SUBJECTS WILLING TO PARTICIPATE IN PARTICIPANT OBSERVATION

Faculty of Natural and Agricultural Sciences

Department of Consumer Sciences

INFORMATION LEAFLET AND CONSENT FORM FOR PARTICIPANT OBSERVATION

Project Title: Development of a Total Quality Management Tool Integrating Sustainability Practices to Address Food Waste: A Case in a University Food Service Unit

Dear Participant

Thank you for your willingness to be the subject of observation in the study to develop, and validate a total quality management tool integrating sustainability practices to address food waste in the university residential food service unit. This information leaflet will help you to decide if you want to participate or not. Before you agree to take part you should fully understand what is involved. If you have any questions that this leaflet does not fully explain, please do not hesitate to ask the researcher.

1) NATURE OF THE INVOLVEMENT

The research study involves the researcher working closely with the participant in the food service unit to develop a tool to address food waste. With your permission, the observation of food related practices and food waste will be photographed and recorded as observation notes.

2) VOLUNTARY NATURE OF PARTICIPATION

Your participation is entirely voluntary and you may withdraw or stop participation at any stage during the study without giving any reason.

3) RISKS INVOLVED

There are **no risks** involved in participating in this study. All information obtained from you will be regarded as confidential.

4) HAS THE STUDY RECEIVED ETHICAL CLEARANCE?

The study has received a written approval from the Research Ethics Committee of the Faculty of Natural and Agricultural Sciences at the University of Pretoria. A copy of the approval letter is available if you wish to have one.

5) COMPENSATION

Your participation is voluntary. No compensation towards your expenses will be given for your participation.

6) CONFIDENTIALITY

The information captured in this observation is strictly confidential and will be used for research purposes at the University of Pretoria and will also be published in scientific journals. You will not be identified in any way in the written report or other publications.

I CONFIRM THAT I UNDERSTAND WHAT THE STUDY IS ABOUT AND I AM PARTCIPATING IN THE PROJECT WILLINGLY.

______________________________ ____________

Signature of participant **Date**

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM I: ETHICAL CLEARANCE

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Ethics Committee

E-mail: ethics.nas@up.ac.za

Date	20 September 2016

ETHICS SUBMISSION: LETTER OF APPROVAL

Name of Applicant	Dr AT Viljoen
Reference number	160205-006
Title	Development of a total quality management tool integrating sustainability practices to address food waste: A case in a university food service unit

Dear Dr Viljoen

The submission conforms to the requirements of the NAS EC. Any amendments must be submitted to the NAS EC on a relevant application form as used for the original application quoting the reference number and detailing the required amendment. An amendment would be for example differentiating within the research target population.

You are required to submit a progress report no later than two months after the anniversary of this application as indicated by the reference number. The progress report document is accessible of the NAS faculty's website: Research/Ethics Committee.

You are required to notify the NAS EC upon the completion or ending of the project using the form Project Completed. Completion will be when the data has been analysed and documented in a postgraduate student's thesis or dissertation, or in a paper or a report for publication.

The digital archiving of data is a requirement of the University of Pretoria. The data should be accessible in the event of an enquiry or further analysis of the data.

The NAS EC wishes you well with your research project.

Yours sincerely,

Chairperson
NAS Ethics Committee

ADDENDUM J: RECRUITMENT MAIL FOR DELPHI EXPERTS

Dear Participant

My name is Boineelo Pearl Lefadola, a Doctoral candidate at the University of Pretoria, working under the supervision of Dr Annemarie Viljoen and Professor Gerrie DuRand.

I am conducting a Delphi survey and your input would be appreciated. The purpose of the survey is to seek the input of experts in order to develop a total quality management tool integrating sustainability practices to address food waste in residential university food service units.

As you have relevant expertise in the management of food service units in the context of university food service units, I am inviting you to participate as an expert in the development of this tool. The survey will take place online through a series of iterative rounds (2-3 rounds). This is the first round of the survey. Participation in this survey is entirely **voluntary** and all information will be treated as **confidential**. If you agree to take part on this survey click this **link**: **Take the Survey**

To opt out click: Click here to unsubscribe

The survey closes on **15 June 2018**.

Thank you for your contribution, your opinion matters.

Many thanks.

B.P. Lefadola

Boineelo Pearl Lefadola
Doctoral Candidate
Department of Consumer and Food Sciences
University of Pretoria
Tel: +267 355 5036
Cell: +267 74079418
Email: u13275004@tuks.co.za or pearl.nkele@mopipi.ub.bw

ADDENDUM K: MAIL REMINDING POTENTIAL DELPHI EXPERTS TO COMPLETE SURVEY

Faculty of Natural and Agricultural Sciences

Dear Participant,

We recently contacted you regarding development of a tool that can be used to address food waste in food service units and we would just like to let you know that if you have not yet completed the survey, there is still time to do so.

Your input is very important to us.

The survey should take no longer than 30 minutes. If you agree to take part on this survey click this **link**: **Take the Survey**

To opt out click: Click here to unsubscribe

The closing date for completing the survey is Friday 15th June, 2018.

Your responses will remain completely confidential.

Thanks very much in advance for helping us with this research - we're looking forward to hearing your thoughts.

Kind regards,

B.P. Lefadola

Boineelo Pearl Lefadola
Doctoral Candidate
Department of Consumer and Food Sciences
University of Pretoria
Tel: +267 355 5035
Cell: +267 74079418
Email: u13275004@tuks.co.za or pearl.nkele@mopipi.ub.bw

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM L: 1ST ROUND DELPHI SURVEY

Delphi Round 1 - Development and Validation of a TQM Tool Integrating Sustainability Practices

Thank you for willing to complete this survey questionnaire.

The purpose of this questionnaire is to develop a total quality management tool that integrates sustainability practices in order to address food waste in food service operations.

This questionnaire will take about 30 minutes of your time. As you work through the survey, use the << and >> buttons in the bottom right and bottom left corners to navigate to the previous and next page. You may change your answers on previous questions. Your answers to this questionnaire will be treated confidentially.

Q1. First, we need a little background information, are you male or female?

- Male
- Female

Q2. What is your age?

- 18 - 29
- 30 - 39
- 40 - 49
- 50-59
- 60+

Q3. Which organisation do you work for?

Q4. What job position do you currently hold in your organisation?

- Food Services Director
- Food Service Manager
- Assistant Food Service Manager
- Academic
- Chef
- Other (please specify)

Q5. How many years have you worked in the food service sector or related organisation?

Q6. What is your highest educational qualification?

- Secondary education
- Tertiary Education

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

○ Postgraduate

○ Other (please specify)

Please review and indicate the extent to which each of the following Total Quality Management Practices and indicators are important in preventing food waste generation in food service operation.

Q7..To what extent are the following quality practices of management important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Management actively participates in quality improvement efforts	○	○	○	○	○
Management holds regular meetings to discuss quality related issues	○	○	○	○	○
Management supports quality improvement efforts by providing the necessary resources	○	○	○	○	○
Food quality policy is taken into consideration in strategic planning	○	○	○	○	○
Food quality data are taken into consideration in decision making	○	○	○	○	○
Food quality policy is communicated throughout the food service unit	○	○	○	○	○
Management gives employees authority to manage food quality problems	○	○	○	○	○
Management sets food quality strategies for employees	○	○	○	○	○
Food quality results are evaluated to check improvements	○	○	○	○	○
Management gives priority to food production processes	○	○	○	○	○

Q8. Please state quality practices of management, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q9. To what extent are the following indicators of employee knowledge and education important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Qualifications of employees are evaluated for relevance with food service	◌	◌	◌	◌	◌
Employees have experience in food service	◌	◌	◌	◌	◌
Employees have the knowledge and know-how related to food service	◌	◌	◌	◌	◌
Employees are trained in topics with regard to their specialty and daily work in different areas of food service	◌	◌	◌	◌	◌
Employees are offered quality orientated training	◌	◌	◌	◌	◌
Resources are provided for staff training	◌	◌	◌	◌	◌

Q10
Please state indicators of employee knowledge and education, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q11. To what extent are the following indicators of employee management and involvement important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Employees who improve food quality are rewarded	◌	◌	◌	◌	◌
Employees are evaluated on how well they ensure food quality	◌	◌	◌	◌	◌
Employees participate in food quality improvement activities	◌	◌	◌	◌	◌
Employees are motivated to improve food quality performance	◌	◌	◌	◌	◌
Systems exist for promoting teamwork across the food service system	◌	◌	◌	◌	◌
Approaches to work promote open communication between departments and food service units	◌	◌	◌	◌	◌
Employees take initiatives during their work processes to solve problems that would impact on food quality	◌	◌	◌	◌	◌
Employees' suggestions on food quality assurance are adopted	◌	◌	◌	◌	◌

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Employees recognise superior quality performance	○	○	○	○	○

Q12. Please state indicators of employee management and involvement, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q13. To what extent are the following indicators of information and analysis important in preventing food waste generation food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
A variety of data collection methods are used to ensure reliability of quality performance data	○	○	○	○	○
There is adequate storage for archiving of information	○	○	○	○	○
Easy retrieval of stored information	○	○	○	○	○
There is systematic analysis of food quality data	○	○	○	○	○

Q14. Please state indicators of information and analysis, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q15. To what extent are the following indicators of supplier quality management important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
There is a solid partnership with suppliers	○	○	○	○	○
Adherence of suppliers to food quality specifications	○	○	○	○	○
Suppliers comply with requested food expiry dates	○	○	○	○	○
Suppliers provide food quantities ordered	○	○	○	○	○
Suppliers comply with the transportation standards for perishable and non-perishable foods	○	○	○	○	○
Timely delivery of food products by suppliers	○	○	○	○	○

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Monitoring and assessing quality performance of suppliers	○	○	○	○	○
Open communication between the food service unit and suppliers	○	○	○	○	○
Written documentation from supplier that quality management procedures and legislation are adhered to.	○	○	○	○	○

Q16. Please state indicators of supplier quality management, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q17. To what extent are the following indicators of process quality management important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Process non-conformities are detected through internal audits	○	○	○	○	○
Critical processes are determined and evaluated	○	○	○	○	○
Determination of areas, processes and points for improvement	○	○	○	○	○
Specific organisational structures have been formulated to support quality improvement	○	○	○	○	○
All employees are provided with work instructions	○	○	○	○	○
Mistakes are precluded in the process design	○	○	○	○	○
Bench marking of quality management practices	○	○	○	○	○
Setting ranges within which non-conformities are tolerated or allowed	○	○	○	○	○

Q18. Please state indicators of process quality management, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Q19. To what extent are the following indicators of customer focus important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
There is a process of collecting customer feedback	◯	◯	◯	◯	◯
Customers are encouraged to submit complaints and proposals for quality improvement	◯	◯	◯	◯	◯
Customer suggestions are taken into consideration for quality improvement	◯	◯	◯	◯	◯
Customers' suggestions are recorded and analysed	◯	◯	◯	◯	◯
Food service unit is in close contact with customers	◯	◯	◯	◯	◯

Q20. Please state indicators of customer focus, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q21. To what extent are the following indicators of process and product quality design, under the purchasing subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
The expected amount of time before a food item should be purchased is fore-casted	◯	◯	◯	◯	◯
Food specifications are developed	◯	◯	◯	◯	◯
Units of measure are specified in purchasing orders	◯	◯	◯	◯	◯
Particular expiry dates are requested when purchasing food items	◯	◯	◯	◯	◯
Only approved suppliers of food are selected	◯	◯	◯	◯	◯
Select and establish a variety of suppliers to ensure supply options	◯	◯	◯	◯	◯

Q22. Please state indicators of process and product quality design, under the purchasing subsystem, other than the ones mentioned above that appear to be important in preventing food waste prevention in food service operations.

Q23. To what extent are the following indicators of process and product quality design, under the receiving subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
There are scheduled hours for receiving					
Deliveries are inspected for quantity, against purchase order and invoice					
Deliveries are inspected against quality specifications					
Deliveries are checked to ensure undamaged packaging					
Expiry dates of deliveries are checked					
Temperature of perishable food is checked upon delivery					
Food items that do not meet quality specifications are rejected					
All newly received food items are date marked					
Received food items are promptly transferred to appropriate storage areas					

Q24. Please state indicators of process and product quality design, under the receiving subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q25. To what extent are the following indicators of process and product quality design, under the storage and inventory subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Storage areas have adequate dimensions for storing all food-related items					
Storage areas meet specifications for walls, ceilings, floors, windows, baseboards, floor drains, lightning and ventilation					
Storage areas protect food from direct sunlight, heat, moisture and smoke					
Storage areas are regularly cleaned					
Storage areas have insect and rodent control					

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Temperature of refrigerators is regularly checked	○	○	○	○	○
Relative humidity of refrigerators is regularly checked	○	○	○	○	○
Chemicals and cleaning agents are stored separately from food items	○	○	○	○	○
The organisation of food items in storage areas prevents cross contamination	○	○	○	○	○
The FIFO (First-In, First-Out) rotation system is applied at all times	○	○	○	○	○
Expiry dates of food items are regularly checked	○	○	○	○	○
Raw food is stored separately from cooked or ready to eat food	○	○	○	○	○
Food is always kept covered	○	○	○	○	○
A continuous track of food items held in storage is kept	○	○	○	○	○

Q26. Please state indicators of process and product quality design, under the storage and inventory subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q27. To what extent are the following indicators of process and product quality design, under the issuing stock subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
A requisition form is used to issue food from storage to production	○	○	○	○	○
Only the quantity of food needed as specified on an authorised production record is removed from the storage	○	○	○	○	○
Requested items are measured using appropriate measuring equipment before issuance	○	○	○	○	○
Food items issued are checked against standardised recipes before production	○	○	○	○	○
Unused food is returned to appropriate storage area	○	○	○	○	○

Q28. Please state indicators of process and product quality design, under the issuing stock subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q29. To what extent are the following indicators of process and product quality design, under the preparation and production subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Use of production schedules	◌	◌	◌	◌	◌
Ingredients are accurately measured with appropriate measuring equipment	◌	◌	◌	◌	◌
Food items requiring thawing are properly thawed	◌	◌	◌	◌	◌
Food is not exposed to the temperature danger zone for more than 4 hours	◌	◌	◌	◌	◌
Cooking temperature is properly controlled during production	◌	◌	◌	◌	◌
Food is cooked to appropriate cooking time	◌	◌	◌	◌	◌
Standardised recipes are adhered to during production	◌	◌	◌	◌	◌
Food is cooked to appropriate, stipulated quality standards	◌	◌	◌	◌	◌
Food is cooked to appropriate internal temperature	◌	◌	◌	◌	◌
Food is evaluated for quality prior to meal service	◌	◌	◌	◌	◌

Q30. Please state indicators of process and product quality design, under the preparation and production subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q31. To what extent are the following indicators of process and product quality design, under the holding, chilling, freezing and reheating subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Specialised equipment with approved temperature controls is used	◌	◌	◌	◌	◌
Food holding temperatures are monitored	◌	◌	◌	◌	◌
An appropriate procedure is followed for chilling and freezing food	◌	◌	◌	◌	◌
An appropriate procedure is followed for reheating food	◌	◌	◌	◌	◌
Reheating is done in small batches	◌	◌	◌	◌	◌
Frozen food is reheated to appropriate service temperature	◌	◌	◌	◌	◌
Sensory quality is retained during reheating	◌	◌	◌	◌	◌

Q32. Please state indicators of process and product quality design, under the holding, chilling, freezing and reheating subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q33. To what extent are the following indicators of process and product quality design, under the distribution subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Proper equipment is used for distribution	◌	◌	◌	◌	◌
Temperature of food is properly controlled	◌	◌	◌	◌	◌
Time at which food is held under distribution is controlled	◌	◌	◌	◌	◌

Q34. Please state indicators of process and product quality design, under the distribution subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q35. To what extent are the following indicators of process and product quality design, under the service subsystem, important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Front-of-house staff check quality of food before service	◌	◌	◌	◌	◌
Portions of food are verified upon receipt from back of the house	◌	◌	◌	◌	◌
Bain-maries, chaffing dishes and heated cabinets are at correct temperatures	◌	◌	◌	◌	◌
Internal food temperature is measured and recorded	◌	◌	◌	◌	◌
An appropriate food temperature is maintained during service	◌	◌	◌	◌	◌
Food is kept covered until service	◌	◌	◌	◌	◌
Standardised serving utensils are used for portioning	◌	◌	◌	◌	◌
Portioning is done correctly	◌	◌	◌	◌	◌
Food is neatly plated and presented	◌	◌	◌	◌	◌
Leftovers are properly handled and stored	◌	◌	◌	◌	◌
The amount of time food is held below temperature danger zone is highly controlled	◌	◌	◌	◌	◌

Q36. Please state indicators of process and product quality design, under the service subsystem, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Please review and indicate the extent to which each of the following sustainability practices and indicators are important in preventing food waste generation in food service operations.

Q37. To what extent are the following indicators of sustainable food practices important in preventing food waste generation in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Use of locally sourced ingredients	◌	◌	◌	◌	◌
Purchase and utilisation of food in season	◌	◌	◌	◌	◌
Cook to order	◌	◌	◌	◌	◌

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Employ creative practices of utilising leftovers	○	○	○	○	○
Use garnishes to a limited extent	○	○	○	○	○

Q38. Please state indicators of sustainable food practices, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

Q39. To what extent are the following indicators of environmental focused sustainable practices important in preventing food waste prevention in food service operations?

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Less energy consumption cooking methods are adopted	○	○	○	○	○
Adherence to optimal cooking times	○	○	○	○	○
Batch cooking	○	○	○	○	○
Reduced food miles	○	○	○	○	○
Limited use of running water	○	○	○	○	○
Use of just enough water for production	○	○	○	○	○

Q40. Please state indicators of environmental focused sustainable practices, other than the ones mentioned above that appear to be important in preventing food waste generation in food service operations.

THANK YOU FOR COMPLETING THE SURVEY.

ADDENDUM M: 2nd ROUND DELPHI SURVEY

Delphi Round 2 - Development and Validation of a TQM Tool Integrating Sustainability Practices

Start of Block: Default Question Block

Thank you very much for completing the first round of the Delphi survey. In Round 2, we are requesting that you rate and comment on the statements where there was no clear consensus in Round 1 as well as additional statements suggested by the expert panel. The purpose of this round is to reach consensus on items that are important in addressing food waste in the university food service sector.

This questionnaire will take about 30 minutes of your time.

Your answers to this survey will be treated confidentially.

End of Block: Default Question Block

Start of Block: Default Question Block

Please review and indicate the extent to which each of the following Total Quality Management Practices and indicators are important in preventing food waste generation in food service operations.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Q1. To what extent are the following quality practices of management important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Food quality policy is taken into consideration in strategic planning.					
Management gives employees authority to manage food quality problems.					
Management sets food quality strategies for employees.					
Management liaises with personnel to get their input regarding quality policies and their implementation.					

Q2. Please comment on your ratings of the quality practices of management above.

____

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Q3. To what extent are the following indicators of employee knowledge and education important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Qualifications of employees are evaluated for relevance with food service	○	○	○	○	○
Employees have experience in food service.	○	○	○	○	○
Employees are trained in topics with regard to their specialty and daily work in different areas of food service.	○	○	○	○	○
Employees are offered quality orientated training	○	○	○	○	○
Training newly appointed staff members prior to assumption of duty	○	○	○	○	○
Training employees in all control measures to minimize food waste	○	○	○	○	○

Q4. Please comment on your ratings for indicators of employee knowledge and education above.

____

Q5. To what extent are the following indicators of employee management and involvement important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Employees who improve food quality are rewarded.	○	○	○	○	○
Employees are evaluated on how well they ensure food quality.	○	○	○	○	○
Systems exist for promoting teamwork across the food service system.	○	○	○	○	○
Approaches to work promote open communication between departments and food service units.	○	○	○	○	○
Change management of personal attitudes of employees towards quality management and waste reduction.	○	○	○	○	○
Employees are provided with feedback on performance to encourage continuous improvement.	○	○	○	○	○
Job description in terms of food quality is very clear.	○	○	○	○	○

Q6. Please comment on your ratings for indicators of employee management and involvement above.

____

Q7. To what extent are the following indicators of information and analysis important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
A variety of data collection methods are used to ensure reliability of quality performance data.	○	○	○	○	○
Accurate data recording.	○	○	○	○	○
There is adequate storage for archiving information.	○	○	○	○	○
Easy retrieval of stored information.	○	○	○	○	○
Information is readily available for analysis at any given time.	○	○	○	○	○
Analysed data is used to influence decisions.	○	○	○	○	○
Systems for tracking food waste and surplus are available.	○	○	○	○	○

Q8. Please comment on your ratings for indicators of information and analysis above.

____

Q9. To what extent are the following indicators of supplier quality management important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
There is a solid partnership with suppliers.	○	○	○	○	○
Written documentation from supplier that quality management procedures are adhered to.	○	○	○	○	○
Supplier delivery equipment is frequently inspected.	○	○	○	○	○
Suppliers use packaging materials that provide adequate protection of food during transportation.	○	○	○	○	○

Q10. Please comment on your ratings for indicators of supplier quality management above.

____

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Q11. To what extent are the following indicators of process quality management important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Process non-conformities are detected through internal audits.	○	○	○	○	○
Setting ranges within which non-conformities are tolerated or allowed.	○	○	○	○	○
Hazard Analysis and Critical Control Points (HACCP) system is put in place.	○	○	○	○	○
Good Manufacturing Practices (GMPs) are put in place.	○	○	○	○	○

Q12. Please comment on your ratings of indicators of process quality management above.

____

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Q13. To what extent are the following indicators of customer focus important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Customers are encouraged to submit complaints and proposals for quality improvement.	◯	◯	◯	◯	◯
Customer suggestions are taken into consideration for quality improvement.	◯	◯	◯	◯	◯
Customers' suggestions are recorded and analysed.	◯	◯	◯	◯	◯
There is open communication with customers.	◯	◯	◯	◯	◯
Management of customer expectations.	◯	◯	◯	◯	◯

Q14. Please comment on your ratings of indicators of customer focus above.

____

Q15. To what extent are the following indicators of process and product quality design, under the purchasing subsystem, important in prevention of food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
The expected amount of time before a food item should be purchased is forecasted.	◯	◯	◯	◯	◯
Changes in the menu are communicated on time to optimize ordering.	◯	◯	◯	◯	◯

Q16. Please comment on your ratings of indicators of process and product quality design, under the purchasing subsystem above.

____

Q17. To what extent is the following indicator of process and product quality design, under the receiving subsystem, important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
There are scheduled hours for receiving.	◯	◯	◯	◯	◯

Q18 Please comment on your rating of the indicator of process and product quality design, under the receiving subsystem above.

____

Q19 To what extent are the following indicators of process and product quality design, under the storage and inventory subsystem, important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Storage areas have adequate dimensions for storing all food related items.	◌	◌	◌	◌	◌
Adequacy of containers for storage of food.	◌	◌	◌	◌	◌

Q20. Please comment on your rating of indicators of process and product quality design, under the receiving subsystem above.

____

Q21. To what extent are the following indicators of process and product quality design, under the issuing stock subsystem, important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
A requisition form is used to issue food from storage to production.	◌	◌	◌	◌	◌
Requested items are measured using appropriate measuring equipment before issuance.	◌	◌	◌	◌	◌
Effective production planning that enables issuance of the correct ingredients at the right quantities.	◌	◌	◌	◌	◌

Q22. Please comment on your rating of indicators of process and product quality design, under the issuing stock subsystem above.

____

Q23. To what extent is the following indicator of process and product quality design, under the holding, chilling, freezing and reheating subsystem, important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Minimize holding time between reheating and serving.	○	○	○	○	○

Q24. Please comment on your rating of the indicator of process and product quality design, under the holding, chilling, freezing and reheating subsystem above.

____

Q25. To what extent is the following indicator of process and product quality design, under the distribution subsystem, important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Proper packaging of food distributed.	○	○	○	○	○

Q26. Please comment on your rating of the indicator of process and product quality design, under the distribution subsystem above.

____

Q27. To what extent are the following indicators of process and product quality design, under the service subsystem, important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Standardised serving utensils are used for portioning.	○	○	○	○	○
Food is neatly presented.	○	○	○	○	○

Q28. Please comment on your rating of the indicators of process and product quality design, under the service subsystem above.

____

Page Break

Please review and indicate the extent to which each of the following sustainability practices are important in preventing food waste generation in food service operations.

Q29. To what extent are the following indicators of sustainable food practices important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Use of locally sourced ingredients.	○	○	○	○	○
Purchase and utilisation of seasonal food.	○	○	○	○	○
Purchase and utilisation of organic food.	○	○	○	○	○
Use garnishes to a limited extent.	○	○	○	○	○
Make changes in the menu to adapt to available products.	○	○	○	○	○
Traceable food supply chain.	○	○	○	○	○
Follow the food safety and sanitation regulations.	○	○	○	○	○

Q30. Please comment on your rating of the indicators of sustainable food practices above.

____

Q31. To what extent are the following indicators of environmental focused sustainable practices important in preventing food waste generation in food service operations?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Less energy consumption cooking methods are adopted.	○	○	○	○	○
Adherence to optimal cooking times.	○	○	○	○	○
Batch cooking.	○	○	○	○	○
Reduced food miles.	○	○	○	○	○
Reduction of the amount of water used during production.	○	○	○	○	○
Conservation of energy when cooking, for example, turning off appliances when not in use.	○	○	○	○	○
Kitchen with good ventilation and temperature control.	○	○	○	○	○
Keeping cool air in refrigerator from going out and reduction of opening frequency.	○	○	○	○	○
Regular cleaning and maintenance of kitchen appliances.	○	○	○	○	○

Q32. Please comment on your rating of the indicators of environmental focused sustainable practices above.

THANK YOU FOR COMPLETING THE SURVEY.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM N: CONSENT FORM FOR SUBJECTS PARTICIPATING IN THE DELPHI SURVEY

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Natural and Agricultural Sciences

INFORMATION LEAFLET AND INFORMED CONSENT

RESEARCH PROJECT ON DEVELOPMENT OF A TOTAL QUALITY MANAGEMENT TOOL INTEGRATING SUSTAINABILITY PRACTICES TO ADDRESS FOOD WASTE IN FOOD SERVICE UNITS.

Dear Participant

1) INTRODUCTION

We invite you to **volunteer** to participate in a research study. This information leaflet will help you to decide if you want to participate or not. Before you agree to take part you should fully understand what is involved. If you have any questions that this leaflet does not fully explain, please do not hesitate to contact the researcher or her supervisors.

2) THE NATURE AND PURPOSE OF THIS STUDY

The purpose of this study is to develop a Total Quality Management tool that integrates sustainability practices, in order to address food waste at university residential food service units.

There is limited information about food waste in the context of university food service units in South Africa. Additionally, while efforts have been made to address food waste in general, no study has focused on integrating sustainability practices into the total quality management approach to possibly address food waste. To be able to develop a total quality management tool that integrates sustainability practises it is necessary to explore the concept through engagement of experts in the field.

The information obtained through this study will enable us to develop a Total Quality Management tool that integrates sustainability practices as an intervention for food waste prevention and reduction.

3) EXPLANATION OF PROCEDURES TO BE FOLLOWED

The study will perform three Delphi Technique Survey runs, supported by the Qualtrics online software program as described below:

- In the first run, the draft tool (based from an extensive literature review) containing open - ended questions will be presented to participants to review and evaluate the importance of each indicator. Open-ended questions will be included so as to make provision for suggestions by participants.

- In the second run, the tool will be modified based on the results of the first survey; statistics (means and modes) of the first run plus the open-ended responses of all participants will be included. Participants will be asked to review and re-evaluate the importance of all the indicators with consideration of the extent to which the indicator can influence food waste generation in food service units.
- This procedure will be repeated so as to reach consensus.

Please note that each of the survey runs may take **approximately 30 minutes** to complete.

4) RISKS INVOLVED

There are **no risks** involved in participating in this survey. All information obtained from you will be regarded as confidential.

5) WHAT ARE YOUR RIGHTS AS THE PARTICIPANT?

Your participation is entirely voluntary and you may withdraw or stop participation at any stage during the study without giving any reason.

6) HAS THE STUDY RECEIVED ETHICAL CLEARANCE?

The study has received a written approval (Reference number: 160205-006) from the Research Ethics Committee of the Faculty of Natural and Agricultural Sciences at the University of Pretoria. A copy of the approval letter is available if you wish to have one.

7) COMPENSATION

Your participation is voluntary. No compensation towards your expenses will be given for your participation.

8) CONFIDENTIALITY

The information captured in this survey is strictly confidential and will be used for research purposes at the University of Pretoria and will also be published in scientific journals. You will not be identified in any way in the written report or other publications.

I CONFIRM THAT I UNDERSTAND WHAT THE STUDY IS ABOUT AND I AM PARTICIPATING IN THE PROJECT WILLINGLY.

____________________________ ____________

Signature of participant **Date**

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM O: LITERATURE MATRIX OF REVIEWED TQM STUDIES

Author, year, title	Aim	Methodology, study site	TQM Practices
1. Al-Ababneh, M., & Lockwood, A. (2012). Implementing total quality management in the hotel industry. *Journal of Tourism & Hotel Management*.	To explore the critical success factors necessary for implementation in hotels.	Survey	Top management commitment leadership support Quality department Supplier relationship Quality data and reporting Products / Service design Employee management Process management Education and training Continuous improvement Customer focus Quality planning
2. Anderson, M., & Sohal, A. S. (1999). A study of the relationship between quality management practices and performance in small businesses. *International Journal of quality & Reliability management*.	Examines the relationship between quality management practices and performance in small businesses.	Survey, 62 respondents of small businesses	Leadership Strategy, policy and planning Information and analysis People management Customer focus Quality of processes, product and service practices
3. Baird, K., Hu, K. J., & Reeve, R. (2011). The relationships between organizational culture, total quality management practices and operational performance. *International Journal of Operations & Production Management*.	Examines both the direct and indirect association of TQM practices with operational (quality and inventory management) performance.	Survey of 364 business units encompassing both the manufacturing and service industries in Australia.	Quality data and reporting Supplier quality management Product/service design Process management
4. Behara, R. S., & Gundersen, D. E. (2001). Analysis of quality management practices in services. *International Journal of Quality & Reliability Management*.	Analysis of quality management practices in services.	Survey of 170 US service firms.	Compensation Benchmarking Training management Empowerment Technology management Assessment Process management Participation Teamwork Training
5. Benson, P. G., Saraph, J. V., & Schroeder, R. G. (1991). The effects of organizational context on quality management: an empirical investigation. *Management science*, *37*(9), 1107-1124.	Proposes a system-structural model of quality management that relates organizational quality context.	Survey, 152 managers from manufacturing and service companies.	Divisional top management leadership for quality The role of the quality department Training Product / service design Supplier quality management Process management (process design and control)

5. (continues)			Quality data and reporting Employee relations
6. Bou, J. C., & Beltrán, I. (2005). Total quality management, high-commitment human resource strategy and firm performance: an empirical study. *Total Quality Management & Business Excellence*, *16*(1), 71-86.	Examine whether TQM and a high-commitment strategy exert an interaction influence on the organizational results.	Survey, 222 Spanish service firms.	Customer orientation Process orientation Continuous improvement
7. Cetindere, A., Duran, C., & Yetisen, M. S. (2015). The effects of total quality management on the business performance: An application in the province of Kütahya. Procedia economics and finance, 23, 1376-1382.	To investigate the effect of TQM on business performance.	Survey on quality certified companies at Kutahya.	Training Leadership Continuous improvement Internal customer External customer
8. Dabestani, R., Taghavi, A., & Saljoughian, M. (2014). The relationship between total quality management critical success factors and knowledge sharing in a service industry. *Management and Labour Studies*, *39*(1), 81-101.	Investigates the role of employees' different forms of knowledge sharing appreciation in their tendency to use TQM critical success factors (CSFs).	Case study, Interviewing employees of the IT department of one of the largest companies in Middle East.	Leadership and commitment Supplier relationship Competitive benchmarking Teamwork Training Customer focus Employee involvement Communication Get things right first time Process improvement
9. Fotopoulos, C. V., & Psomas, E. L. (2010). The structural relationships between TQM factors and organizational performance. *The TQM journal*.	To determine the relationships between the total quality management (TQM) factors and organizational performance.	370 Greek companies, using the questionnaire method.	Quality practices of the top management Employee involvement Customer focus Process and data quality management Quality tools and techniques
10. Fuentes, M. M. F., Montes, F. J. L., & Fernández, L. M. M. (2006). Total quality management, strategic orientation and organizational performance: the case of Spanish companies. *Total Quality Management & Business Excellence*, *17*(3), 303-323.	Examines the relationship between strategy and Total Quality Management TQM) implementation.	Survey, 273 respondents from Spanish companies (manufacturing and service)	Leadership Teamwork (cooperation) Customer focus Continuous improvement Process management Employee fulfilment Learning
11. Hasan, M., & Kerr, R. M. (2003). The relationship between total quality management practices and organisational performance in service organisations. *The TQM Magazine*.	To examine the relationship between TQM practices and organisational performance in service organisations.	Survey, Australian service organisations.	Top management commitment Employee involvement Training Supplier quality Quality cost Service design Quality techniques Benchmarking Customer satisfaction

12. Hoang, D. T., Igel, B., & Laosirihongthong, T. (2006). The impact of total quality management on innovation. *International journal of quality & reliability management*.	To investigate the relationship between total quality management (TQM) practices and innovation performance in the Vietnamese industry context.	Survey, 222 managers in Vietnamese manufacturing and service industry.	Top management commitment Employee involvement Employee empowerment Education and training Teamwork Customer focus Process management Information and analysis system Strategic planning Open organisation Service culture
13. Jaca, C., & Psomas, E. (2015). Total quality management practices and performance outcomes in Spanish service companies. Total Quality Management & Business Excellence, 26(9-10), 958-970.	To determine the latent factors of the TQM practices implemented as well as the dimensions of the respective performance outcomes.	Survey, 72 Spanish service companies	Quality practices of top management Process management Employee quality management Customer focus Employee knowledge and education
14. Jaeger, M., & Adair, D. (2016). Perception of TQM benefits, practices and obstacles. *The TQM journal*.	To identify the perception of total quality management (TQM) benefits, practices and obstacles in Kuwaiti industrial organizations.	Kuwaiti industrial organizations certified against ISO 9001:2000	Management commitment Customer focus Management system related Employee involvement
15. Kahreh, Z. S., Shirmohammadi, A., & Kahreh, M. S. (2014). Explanatory study towards analysis the relationship between Total Quality Management and Knowledge Management. *Procedia-Social and Behavioral Sciences*, *109*(2014), 600-604.	To investigate the relationship between Total Quality Management and Knowledge Management.	Survey, Banking industry	Supplier relations Benchmarking Quality management Continuous process improvement
16. Kaluarachchi, K. A. S. P. (2010). Organizational culture and total quality management practices: a Sri Lankan case. *The TQM Journal*.	To identify the effect of organizational culture (OC) on the total quality management (TQM) practices of a Sri Lankan public sector hospital.	Direct observations, short-time interviews, participative observations, in-depth interviews, and obtaining relevant documentary evidence. Sri Lankan public hospital	Senior management commitment Staff commitment Stakeholder focus Continuous improvement Quality culture Measurement and feedback Learning organisation
17. Karia, N., & Asaari, M. H. A. H. (2006). The effects of total quality management practices on employees' work-related attitudes. *The TQM magazine*.	To examine the impact of TQM practices on employees' work related attitudes.	Survey, Malaysian private and public organisations that were ISO certified.	Customer focus Training and education Empowerment and education Continuous improvement
18. Ketikidis, P. H., Koh, S. L., Gunasekaran, A., Demirbag, M., Tatoglu, E., Tekinkus, M., & Zaim, S. (2006). An analysis of the relationship between TQM implementation and organizational performance. *Journal of manufacturing technology management*.	To determine the critical factors of total quality management (TQM) and to measure their effect on organizational performance of SMEs operating in Turkish textile industry.	Survey, respondents operating in Turkish textile industry.	Quality data and reporting Role of top management Employee relations Supplier quality management Training Quality policy Process management

19. Kim, D. Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of operations management*, *30*(4), 295-315.	To examine the associations among different quality management (QM) practices.	Survey, ISO 9001 certified manufacturing or service firms in Canada.	Management leadership Training Employee relations Supplier quality management Customer relations Quality data and reporting Product/service design Process management
20. Krittanathip, V., Rakkarn, S., Cha-um, S., & Konkhum, P. (2013). Development of Weighting on Self-assessment Evaluation for Total Quality Management: A Case Study of Retail Sectors. *Procedia-Social and Behavioral Sciences*, *88*, 37-48.	Development of weighting on self-assessment evaluation for total quality in the retail sector.	Observation and interview, retail sectors in Thailand.	Leadership and clustering Strategic policy Customer and marketing Information system and analysis Human resource Business management and supply chain Logistic management Safety, health and environment Business results
21. Li, J. H., Anderson, A. R., & Harrison, R. T. (2003). Total quality management principles and practices in China. *International Journal of Quality & Reliability Management*.	Considers the role and practices of total quality management in China.	Review, tool development and validation in 428 Northern Chinese companies.	Leadership Quality vision and plan Process control and improvement Product design Quality audit and evaluation Supplier quality management Education and training Customer focus
22. Modgil, S., & Sharma, S. (2016). Total productive maintenance, total quality management and operational performance. *Journal of Quality in Maintenance Engineering*.	To investigate the impact of total productive maintenance (TPM) and total quality management (TQM) practices on operational performance and their inter-relationship.	Survey, 410 Indian pharmaceutical plants	Quality data and reporting Product innovation Research and development (R&D) management Technology management
23. Mosadeghrad, A. M. (2015). Developing and validating a total quality management model for healthcare organisations. *The TQM Journal*.	To develop a total quality management (TQM) model for healthcare organisations and validate it using a sample of Iranian healthcare organisations.	Cross sectional survey, Iranian healthcare organisations	Leadership and management Strategic quality planning Education and training Quality culture Customer management Employee management Information management Supplier management Resource management Process management

24. Munizu, M. (2013). Total Quality Management (TQM) Practices toward product quality performance: Case at food and beverage industry in Makassar, Indonesia. *IOSR Journal of Business and Management (IOSR-JBM)*, *9*(2), 55-61.	To test and analyse the effect of TQM practices implementation on product quality performance.	Survey, food and beverage industry in Makassar, Indonesia	Leadership Strategic planning Customer focus Information and analysis People management Process management
25. Muturi, D., Ho, S., Douglas, A., Nawelwa, J., Sichinsambwe, C., & Mwanza, B. G. (2015). An analysis of total quality management (TQM) practices in Zambian secondary schools. *The TQM Journal*.	To explore total quality management (TQM) practices in secondary schools in Lusaka province in Zambia.	Survey, 120 secondary school teachers at Lusaka.	Teamwork Continuous improvement Training Collaboration Management commitment School culture
26. Nair, G. K., & Choudhary, N. (2016). Influence of critical success factors of total quality management on financial and non-financial performance of hospitality industry: an empirical study. *International Journal of Productivity and Quality Management*, *17*(4), 409-436.	Examine the influence of critical success factors (CSFs) of total quality management (TQM) on the financial and non-financial performance in the hospitality industry.	Survey, 331 respondents in the hospitality industry	Customer management Top management leadership People management Organizational learning Process management Continual improvement Quality Information management Supplier management
27. Prajogo, D. I., & McDermott, C. M. (2005). The relationship between total quality management practices and organizational culture. *International Journal of Operations & Production Management*.	Explores the relationship between total quality management (TQM) practices and organizational culture.	Survey, 194 managers in Australian industry encompassing both manufacturing and non-manufacturing sectors.	Leadership Strategic planning Customer focus Information and analysis Process management
28. Prajogo, D. I., & Sohal, A. S. (2003). The relationship between TQM practices, quality performance, and innovation performance. *International journal of quality & reliability management*.	Examines the relationship between total quality management (TQM) and innovation performance and compares the nature of this relationship against quality performance.	Survey of 194 managers in Australian industry encompassing both manufacturing and non-manufacturing sectors.	Leadership Strategic planning Customer focus Information and analysis People management Process management

29. Psomas, E. L., & Fotopoulos, C. V. (2010). Total quality management practices and results in food companies. *International Journal of Productivity and Performance Management*.	To factorize the TQM concept by analysing the TQM practices implemented and the results achieved from implementing such practices.	Survey, 92 Greek food companies	Process and data quality management Employee involvement Customer focus Quality practices of top management
30. Psomas, E. L., & Jaca, C. (2016). The impact of total quality management on service company performance: evidence from Spain. *International Journal of Quality & Reliability Management*.	To explore the impact of TQM factors on performance dimensions of service companies.	Survey, Spanish service sector.	Quality practices of top management Employee quality management Process management Employee knowledge and education Customer focus
31. Psomas, E., Vouzas, F., & Kafetzopoulos, D. (2014). Quality management benefits through the "soft" and "hard" aspect of TQM in food companies. The TQM Journal.	To examine the binary character of total quality management (TQM) in food companies and to determine the impact of the two aspects of TQM – the "soft" and "hard" – on the quality management benefits.	Survey, 90 Greek food companies.	Continuous improvement Top management commitment Customer focus Human resource development Fact-based decision making Strategic quality planning Process focus Employee involvement Supplier involvement
32. Sadikoglu, E., & Olcay, H. (2014). The effects of total quality management practices on performance and the reasons of and the barriers to TQM practices in Turkey. *Advances in Decision Sciences*.	To investigate impacts of TQM on performance.	Cross sectional survey, Turkey	Leadership Knowledge and process management Training Supplier quality management Customer focus Strategic quality planning
33. Sadikoglu, E., & Zehir, C. (2010). Investigating the effects of innovation and employee performance on the relationship between total quality management practices and firm performance: An empirical study of Turkish firms. *International journal of production economics*, *127*(1), 13-26.	Investigating the effects of innovation and employee performance on the relationship between TQM practices and firm performance.	Cross-sectional survey methodology — ISO9001:2000 certified firms in different industries in the Marmara region in Turkey.	Leadership Knowledge and process management Training Supplier quality management Customer focus Strategic quality planning
34. Sila, I., & Ebrahimpour, M. (2004). An examination of quality management in luxury hotels. *International journal of hospitality & tourism administration*, *4*(2), 33-59.	To analyse and compare the total quality management (TQM) practices of three luxury hotels.	Semi structured interview, hotel managers	Leadership Strategic planning Guest and market focus Information and analysis Human resource focus Process management Supplier management

35. Singh, R. (2015). Empirical examination of the impact of total quality services on hospitality industry business. *Journal of Quality Assurance in Hospitality & Tourism*, *16*(4), 389-413.	Focuses on the effective use of Total Quality Service (TQS) practices for hotel groups in northern India.	Survey, 152 respondents in managerial positions of hotels in Northern India.	Customer focus Continuous improvement Team work Management commitment Training
36. Talib, F., Rahman, Z., & Qureshi, M. N. (2011). Prioritising the practices of total quality management: An analytic hierarchy process analysis for the service industries. *Total Quality Management & Business Excellence*, *22*(12), 1331-1351.	To categorise TQM practices and examine its relative importance for better implementation in sevice industries.	Multi phased process, service industries	Top-management commitment Quality culture Continuous improvement and innovation Quality systems Benchmarking (Strategic planning Employee encouragement Employee involvement Training and education Teamwork Information and analysis Supplier management Communication Product and service design Process management Customer focus Human resource management
37. Talib, F., Rahman, Z., & Qureshi, M. N. (2012). Total quality management practices in Indian hospitality industry: some key findings from survey. In *Proceedings of National Conference on Emerging Challenges for Sustainable Business (ECSB-2012), Indian Institute of Technology Roorkee, Roorkee, June 1* (Vol. 2, pp. 1866-1888).	Identified key TQM practices in Indian hospitality industry.	Survey, Indian hospitality industry.	Top management commitment Customer focus Training and education Continuous improvement and innovation Supplier management Employee involvement Information and analysis Process management Quality systems Benchmarking Quality culture Human resource management Strategic planning Employee encouragement Teamwork Product and service design Communication
38. Talib, H. H. A., Ali, K. A. M., & Idris, F. (2013). Quality management framework for the SME's food processing industry in Malaysia. *International Food Research Journal*, *20*(1).	To identify CSF of quality management practices of the Small and Medium Enterprises (SMEs) in the Malaysian food industry.	Review, Interviews Small and Medium Enterprises (SMEs) in the Malaysian food industry	Leadership Corporate planning Human resource management Customer focus Supplier focus Information management Process management Quality assurance

39. Talib, F., Rahman, Z., & Qureshi, M. N. (2013). An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies. *International journal of quality & reliability management*.	To investigate the relationship between total quality management (TQM) practices and quality performance in Indian service companies.	Survey, 600 service companies (i.e. Healthcare, Banking, Information and Communication Technology (ICT), and Hospitality) in India i	Top management commitment Customer focus Training and education Continuous improvement and innovation Supplier management Employee involvement Information and analysis Process management Quality systems Benchmarking Quality culture Strategic planning Employee encouragement Teamwork Communication Product and service design
40. Tarí, J. J. (2005). Components of successful total quality management. *The TQM magazine*.	To identify the components of total quality management (TQM	Literature review and a survey based on 106 ISO 9000 certified firms in Spain.	Customer focus Customer satisfaction Staff indicators Process management Leadership Suppliers management Learning Quality performance Quality planning Social impact Continuous improvement Employee management Employee satisfaction
41. Tari, J. J., Molina, J. F., & Castejon, J. L. (2007). The relationship between quality management practices and their effects on quality outcomes. *European journal of operational research*, *183*(2), 483-501.	To identify the relationships between quality management practices, and to examine the direct and indirect effects of these practices on quality outcomes.	Cross-section survey, 106 certified firms in Spain	Leadership Quality planning Human resource management Supplier management Customer focusProcess management Continuous improvement Learning
42. Temtime, Z. T. (2003). The moderating impacts of business planning and firm size on total quality management practices. *The TQM magazine*.	Investigated the relationship between TQM, planning behavior and firm size.	Survey, manufacturing, merchandising and service in the Republic of Botswana.	Customer satisfaction Managerial leadership Employee empowerment Continuous improvement Supplier partnership Quality philosophy/culture Working environment. Measurement and feedback.

43. Tsang, J. H. Y., & Antony, J. (2001). Total quality management in UK service organisations: some key findings from a survey. *Managing Service Quality: An International Journal*.	Analysis of TQM practices in the UK service industry.	Survey, 25 UK service companies	Customer focus Continuous improvement Top management commitment and recognition Teamwork and employee involvement Communication in company Quality system and policy Training and development Cultural change Supervisory leadership Measurement and feedback Supplier partnership/supplier management.
44. Topalović, S. (2015). The implementation of total quality management in order to improve production performance and enhancing the level of customer satisfaction. *Procedia Technology*, *19*, 1016-1022.	Examining the attitudes of corporate clients on a variety of elements implemented TQM process.	Survey, corporate clients of banks in the Republic of Serbia	Commitment of top management
45. Wang, C. H., Chen, K. Y., & Chen, S. C. (2012). Total quality management, market orientation and hotel performance: The moderating effects of external environmental factors. *International journal of hospitality management*, *31*(1), 119-129.	To examine the performance hotels using TQM, market orientation, and the moderating effects of external environmental factors.	Survey, 588 hotel managers in China	Customer focus Internal / external cooperation Continuous improvement Leadership Employee fulfilment Learning Process management
46. Zehir, C., & Sadikoglu, E. (2012). Relationships among Total Quality Management Practices: An Empirical Study in Turkish Industry. *International Journal of Performability Engineering*, *8*(6).	Investigated the relationships between TQM practices and multiple performance measures.	Survey, Turkish ISO certified companies.	Leadership Training Employee management Information and analysis Supplier management Process management Customer focus Continuous improvement Employee performance Firm performance
47. Zhong, J., Ma, Y., Tu, Y., & Li, X. (2016). Supply chain quality management: an empirical study. *International Journal of Contemporary Hospitality Management*.	To focus on supply chain quality (SCQ) in the hospitality industry in China, and to stress the importance of the synergy of quality management (QM) and supply chain management (SCM).	Survey, 1,039 4-5 star hotels in China.	Leadership Benchmarking Customer focus Process management Continuous improvement Employee fulfilment Training Internal/external cooperation Supplier capability Safety

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ADDENDUM P: REVIEW OF SUSTAINABILITY PRACTICES

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
1. Baldwin, C., Wilberforce, N., & Kapur, A. (2011). Restaurant and food service life cycle assessment and development of sustainability standard. *The International Journal of Life Cycle Assessment*, *16*(1), 40-49.	To develop a sustainability standard and certification (i.e., eco-label) program.	Life cycle assessment in U.S. 6 restaurants.	Environmental sustainability • Responsible food purchases from suppliers sourcing food sustainably. • Energy conservation. • Water conservation. • Waste reduction and management. • Environmentally responsible cleaning and paper products.
2. Chen, C. T., Cheng, C. C., & Hsu, F. S. (2015). GRSERV scale: an effective tool for measuring consumer perceptions of service quality in green restaurants. *Total Quality Management & Business Excellence*, *26*(3-4), 355-367.	To develop a Green Restaurant Service Quality scale (GRSERV scale).	Mixed methods (tool development methodological approach), Taiwan.	• Promotes the ideas and policies of environmental protection. • Responds to environmental protection. • Uses more organic food. • Uses more local food. • Uses more sustainable food. • Offers a lot of fresh seasonal produce.
3. Choi, G., & Parsa, H. G. (2007). Green practices II: Measuring restaurant managers' psychological attributes and their willingness to charge for the "Green Practices". *Journal of Foodservice Business Research*, *9*(4), 41-63.	To measure managers' psychological factors (i.e., attitudes, preferences, and involvement) related to Green practice.	Survey, 167 restaurant managers, USA.	Environmental sustainability • Recycling. • Implementing energy saving measures. • Reduction of pollution Health concern • Offer healthy choice entrees • Accurate labelling. • Use organic produce. • Locally grown products. • Use ingredients in season. Social sustainability • Involved in community activities. • Offer benefits to employees.
4. Dewald, B., Bruin, B. J., & Jang, Y. J. (2014). US consumer attitudes towards "green"	Explores what consumers across the USA perceive as "green" restaurants, how they search for them, and if	Survey, 327 respondents, USA.	Environmental sustainability • Chemical and pollution reduction • Recycling

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
restaurants. *Anatolia*, *25*(2), 171-180.	they are willing to pay more for the “green” restaurant experience.		• Energy-efficiency practices • Waste reduction • Disposables reduction • Water-efficiency practices • Sustainable food • Sustainable furnishings and building materials
5. DiPietro, R. B., Cao, Y., & Partlow, C. (2013). Green practices in upscale foodservice operations. *International Journal of Contemporary Hospitality Management*.	The purpose of this paper is to investigate customers’ perceptions and purchase intentions related to green practices in an upscale, green certified restaurant, on a university campus located in the southeastern USA.	Survey, 600 restaurant customers, USA.	Environmental sustainability • Use of local products in the menu • Use of organic products • Use of environmentally friendly products
6. DiPietro, R. B., Gregory, S., & Jackson, A. (2013). Going green in quick-service restaurants: Customer perceptions and intentions. *International Journal of Hospitality & Tourism Administration*, *14*(2), 139-156.	Analyses perceptions of a random sample of quick service restaurant guests in the Midwest regarding the green practices of restaurants in order to determine the impact that these practices may have on satisfaction, the intent to patronize the restaurant, and therefore the bottom line of the businesses.	Survey, 260 respondents from 25 restaurants, Midwest, USA.	Environmental sustainability • Use of local food products • Use of organic foods • Use of environmental friendly products
7. Dogan, H., Nebioglu, O., & Demirag, M. (2015). A comparative study for green management practices in Rome and Alanya restaurants from managerial perspectives. *Journal of Tourism and Gastronomy Studies*, *3*(11).	To find out whether there are differences between Rome and Alanya restaurants’ green management practices from managerial perspectives.	Survey, 181 respondents from Turkish and Italian restaurants (comparative study).	Environmental sustainability • Selective collection of solid residues • Reduction in the use of environmentally dangerous products • Energy-saving, and • Water-saving practices.

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
8. Dutta, K., Umashankar, V., Choi, G., & Parsa, H. G. (2008). A comparative study of consumers' green practice orientation in India and the United States: A study from the restaurant industry. *Journal of Foodservice Business Research*, *11*(3), 269-285.	Investigates the psychological factors (consumers' attitudes, behavioural intentions, and involvement) in relation to Green practices (GP) in the restaurant industry as measured by three concerns (health, social, and environmental).	Survey, 196 respondents in india, 200 in USA.	Environmental sustainability • Recycling paper • Energy conservation • Offer local ingredients on menu • Avoid genetically modified foods Social sustainability • Contribute food to local charities • Increase employee benefits Health concerns • Offer nutritional information on menus • Offer ingredient list on menu
9. Fennell, D., & Markwell, K. (2015). Ethical and sustainability dimensions of foodservice in Australian ecotourism businesses. *Journal of Ecotourism*, *14*(1), 48-63.	Examines the ethics and sustainability of food provision within the specific context of ecotourism.	Content analysis of ecotourism websites, Australia	Food related practices • Food miles / local • Seasonal Environmental practices • Organic • Free range • Natural • Food waste management / composting • Carbon footprint • Reduce, reuse and recycle • Use of chemicals / fertilisers
10. Frash, R. E., DiPietro, R., & Smith, W. (2015). Pay more for McLocal? Examining motivators for willingness to pay for local food in a chain restaurant setting. *Journal of Hospitality Marketing & Management*, *24*(4), 411-434.	Assessed guest perceptions regarding the use of local foods in US chain or multiunit restaurants.	Delphi, consumer survey, U.S.	Environmental sustainability • Locally sourced food • Reduced miles
11. Hilario, J. S. (2014). Responsiveness of fast-food chain managers along Far Eastern	Examined the different factors that may contribute to the responsiveness of fast- food chain restaurant	Ten fast food chain restaurants that were surveyed along FEU-Manila, Philippines.	Environmental sustainability • Chemical and pollution reduction • Recycling

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
University (FEU-Manila) towards the implementation of green practices in restaurants. *Journal Issues ISSN*, *2360*, 8803.	managers towards implementation of green practices.		• Energy-efficiency practices • Waste reduction • Disposables reduction • Water-efficiency practices • Sustainable food (local and organic) • Sustainable furnishings and building materials
12. Hu, H. H., Parsa, H. G., & Self, J. (2010). The dynamics of green restaurant patronage. *Cornell Hospitality Quarterly*, *51*(3), 344-362.	Discusses the relationships between consumers' knowledge of a restaurant's sustainable practices, environmental concern, and ecological behaviour and their intention to patronize a “green” restaurant.	Survey, 393 respondents, Taiwan	Environmental sustainability • Energy efficiency and conservation • Water efficiency and conservation • Recycling and composting • Pollution prevention • Chlorine free paper products • Non toxic cleaning and chemical products • Renewable power • Green building and construction Sustainable food • Sustainably sourced food • Organic food • Locally grown food • Plant based foods
13. Huang, E., Gregoire, M. B., Tangney, C., & Stone, M. K. (2011). Sustainability in hospital foodservice. *Journal of Foodservice Business Research*, *14*(3), 241-255.	Identified hospital foodservice sustainable practices, examined foodservice directors' perceptions and attitudes on sustainability, and explored intention to adopt sustainable practices.	A cross-sectional survey research design using an online questionnaire, Survey Monkey (Portland, Oregon, USA),	Environmental sustainability • Recycling fat, oil, and grease • Recycling cardboard • Selling bottled water • Recycling paper • Using permanent silverware • Recycling batteries • Using Styrofoam cups • Recycling plastic • Recycling aluminium • Recycling newspaper • Using 100% recycled napkins • Serving fair trade coffee • Using eco-friendly cleaning products • Recycling tin cans • Using permanent mugs for drinks • Using biodegradable, disposable products

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
			• Serving locally grown foods • Serving organic food • Composting
14. Iaquinto, A. (2014). Sustainable practices among independently owned restaurants in Japan. *Journal of Foodservice Business Research*, *17*(2), 147-159.	Explores attitudes toward sustainability among a group of restaurateurs in Japan.	Semi-structured interviews, 29 independently owned casual restaurants in Japan.	• Recycling • Energy conservation • Water conservation • Use of local food • Waste reduction • Composting
15. Jang, Y. J., Kim, W. G., & Bonn, M. A. (2011). Generation Y consumers' selection attributes and behavioural intentions concerning green restaurants. *International Journal of Hospitality Management*, *30*(4), 803-811.	To examine the Generation Y consumer segments' selection attributes and behavioral intentions toward green restaurants.	Survey at a university in a Southeastern United States city, 322 respondents.	Environmental sustainability • The restaurant uses ingredients produced in an environmentally friendly way. • The restaurant uses green foods free of pesticide residues. • The restaurant uses natural products. • The restaurant provides information on ingredients of menu items. • The restaurant participates in pro-environmental activities. • The restaurant participates in recycling. • The restaurant uses recycled paper.
16. Jeong, E. H., Jang, S. C. (2010, June 8). Effects of restaurant green practices: Which practices are important and effective? Caesars Hospitality Research Summit (Paper 13).	To find out whether green practices have strong effects on the image of the company and customers' behavioural intentions in the hospitality industry.	Survey, 349 respondents, USA	• Offer recycling bins. • Use of take-out containers that are recyclable. • Recycle the waste. • Use of energy-efficient lighting in seating areas. • Serve beverages in reusable glasses or mugs. • Use of environmentally friendly cleaners for tables and floor. • Use of environmentally friendly cleaners for mugs, glasses, and utensils. • Use of motion detectors for lights in restrooms. • Use of a system which monitors and controls comfortable temperatures efficiently with the HV AC (Heating, Ventilating and Air Conditioning) system. • Use of flow restrictors. • Offer locally products. • Offer organic goods (coffee, milk, fruit, and others).
17. Jeong, E., Jang, S. S., Day, J., & Ha, S. (2014). The impact of eco-friendly practices on green image and customer attitudes: An investigation in a café setting. *International*	Examine the relationships among three constructs; customers' perceived green practices, perceived green image of a restaurant brand, and attitudes toward a restaurant brand, in a	Survey, 361 respondents from a café located on a Midwestern University campus in the United States.	Environmental sustainability • Recyclable take-out containers • Recycling waste • Water-efficient equipment • Energy-efficient equipment

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
Journal of Hospitality Management, *41*, 10-20.	study of Starbucks' customers.		
18. Kim, Y. J., Njite, D., & Hancer, M. (2013). Anticipated emotion in consumers' intentions to select eco-friendly restaurants: Augmenting the theory of planned behaviour. *International Journal of Hospitality Management*, *34*, 255-262.	To examine the relationship between the variables and explain consumers' acceptance of and engagement in ecological behaviour.	Survey, 438 respondents, USA.	• Recycling glass, paper, cardboard, plastic, aluminium, cooking oil. • Using biodegradable, recyclable utensils, cups, and packaging. • Composting food and garden waste. • Reusing leftover soaps/toiletries for staff use or use in public washrooms. • Using natural cleaning alternatives (e.g., lemon juice, vinegar, salt). • Using cage-free eggs. • Use local and regional farms for produce, cheese, and wines. • Use organic items in catering and concessions operations. • Fitting energy-saving devices (e.g., dimmer/time switches, energy-efficient light bulbs). • Monitoring consumption. • Improving insulation. • Installing water-saving devices. • Using economy wash cycle. • Applying environmental policy; communicating policy to consumers. • Purchasing ethical and environmentally friendly products. • Offering environmental training. • Participating in environmental bodies/charities.
19. Kwok, L., Huang, Y. K., & Hu, L. (2016). Green attributes of restaurants: What really matters to consumers?. *International Journal of Hospitality Management*, *55*, 107-117.	Examined which of a restaurant's green attributes consumers deem most important and how consumers' attitudes toward various green attributes affect their behavioural intentions.	Survey, 382 respondents, USA.	Food focused • Serving organic food/ingredients • Serving locally grown food/ingredients Environment focused • Practicing energy efficiency and conservation. • Practicing water efficiency and conservation. • Using renewable power. • Minimizing harmful waste. • Participating in recycling programs. • Participating in composting programs. • Using recyclable products. Administration focused • Demonstrating a commitment to socially responsible "green projects". • Training employees to use green products and implement green practices. • Processing and displaying a "green certification"

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
20. Ma, J., & Ghiselli, R. (2016). Measuring, monitoring, and managing the green practices in mid-sized restaurants in China. *Journal of foodservice business research*, *19*(1), 64-76.	Explored the economic feasibility of adopting **green practices** in medium-sized **restaurants** in China.	Mixed methods, 2 restaurants in China.	Environmental sustainability Solid waste management (adopting recipes using food materials usually thrown, reutilisation of oil.) • Energy efficiency • Reduce water usage
21. Namkung, Y., & Jang, S. S. (2013). Effects of restaurant green practices on brand equity formation: do green practices really matter?. *International Journal of Hospitality Management*, *33*, 85-95.	Examines the effects of green practices at restaurants on customer-based brand equity formation.	Survey of 512 American diners	Green practices focused on food • Locally grown, • Organic, and • Sustainably produced foods Green practices with an environmental focus • Energy efficiency • Water efficiency • Recycling • Pollution prevention • Installing motion sensors in the bathroom to minimize energy consumption • Providing take-out containers that are recyclable • Reduced food miles
22. Perramon, J., del Mar Alonso-Almeida, M., Llach, J., & Bagur-Femenías, L. (2014). Green practices in restaurants: Impact on firm performance. *Operations Management Research*, *7*(1-2), 2-12.	Analysed the impact of green practices on overall performance of restaurants.	Survey, 374 restaurants in Madrid, Spain	Environmental sustainability • Procurement of ecological products. • Reduced use of cleaning agents harmful to the environment. • Energy saving practices. • Water saving practices.
23. Pinard, C. A., Byker, C., Serrano, E., & Harmon, A. H. (2014). National chain restaurant practices supporting food sustainability. *Journal of Hunger & Environmental Nutrition*, *9*(4), 535-545.	To characterize food sustainability trends driven by consumer demand within the restaurant industry.	Website analysis, 20 US restaurants.	• Traceable foods supply chain. • Local food. • Sustainably sourced. • Natural. • Organic. • Cage free. • Non-confined. • Antibiotic/ hormone free. • Animal welfare approved. • Fair trade. • Nutrition labelling.

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
24. Schubert, F. (2008). *Exploring and predicting consumers' attitudes and behaviours towards green restaurants* (Masters Dissertation, The Ohio State University).	To explore customers' attitudes towards eco-friendly food service establishments, i.e. restaurants that engage in green practices.	Survey, 455 respondents, Ohio, USA.	Environmental sustainability • Energy efficiency and conversation. • Water efficiency and conservation. • Recycling and composting. • Pollution prevention • Recycled, tree-free, biodegradable products. • Chlorine free paper products. • Non-toxic cleaning and chemical products. • Green building and construction. • Sustainable food (organic, locally grown, more plant based menu items).
25. Schubert, F., Kandampully, J., Solnet, D., & Kralj, A. (2010). Exploring consumer perceptions of green restaurants in the US. *Tourism and Hospitality Research*, *10*(4), 286-300.	To explore customer perceptions of and attitudes towards eco-friendly food service establishments.	455 customers from the five restaurants, U.S.	Environmental sustainability • Reduce energy usage and waste • Use biodegradable or recycled products • Use organic products • Serve locally grown food
26. Wang, R. (2012). Investigations of important and effective effects of green practices in restaurants. *Procedia-Social and Behavioral Sciences*, *40*, 94-98.	Identify customers' perceived importance of green practices in the restaurant industry, and (2) examine customers' perceptions regarding the performance of green practices in restaurants.	326 respondents, Starbucks, Taiwan	Environmental sustainability • Use a system which monitors and controls comfortable temperature efficiently. • Use of environmentally friendly cleaning agents. • Use of biodegradable take away containers. • Offer organic food on the menu. • Offer fish and seafood harvested from sustainable sources. • Avoid genetically modified food. • Provide recycling bin. • Use water flow restrictions. • Use energy saving bulbs. • Food waste composting. • Only serve customers water on request. • Use motion detectors for lights in restrooms. • Recycling. • Keep main entrance closed • Use locally sourced ingredients.
27. Wang, Y. F., Chen, S. P., Lee, Y. C., & Tsai, C. T. S. (2013). Developing green management standards for	To develop green standards of restaurant management.	Delphi technique, 23 experts, Taiwan.	Green foods (material) **Green food procurement** • Avoid wildlife protected as food materials.

Author, year, title	Aim	Methodology, study site (country)	Dimensions of Sustainability and Performed Activities
restaurants: An application of green supply chain management. *International Journal of Hospitality Management*, *34*, 263-273.			• Local Foods • Food in season • Organic certified food • Certified or inspected safe food • To reduce processed foods • TAP (Traceability Agricultural Product) • Purchase in appropriate quantity and inventory turnover not too low • Efficient stock control (e.g., moisture control, categorized management) • Monitor food expiration date, avoid foods out of shelf life **Green menu planning and cooking** • Healthy cooking • A diversity of dishes and food materials • More vegetables and fruits, less meats, and less than 30% dishes are meat. • Conserving energy and food materials when cooking (e.g., turn off cooking hoods when not in use or avoid wasting food materials) • Appropriate way to cleaning and defrosting (e.g., avoid using running water to defrost) • Adopt less consumption of energy to cook, like blanching, steaming, boiling or cold salad. • Choose appliances not leaching chemicals or toxic metal particles when cooking • Follow the food safety and sanitation regulations for employees in food industry **Green package for take out** • Adopt safe package materials, not leaching chemicals when packing hot foods or reheating. • Adopt package or container is made free of polystyrene. • Adopt package or container is made of recyclable materials. • Adopt package or container is made of biodegradable and composted materials. • Avoid over-package, two layers of package as the maximum. • Adopt long-lasting or reusable materials for package Green kitchen environment Green dining environment Green cleaning and post treatment Green management policy Green management and social responsibility (people)

ADDENDUM Q: PRELIMINARY TOOL AFTER PHASE 1

The following dimensions and indicators were generated from the systematic review of the literature from Phase 1:

Components	Dimensions	Indicators
TQM Practices	Quality practices of top management	1. Top management actively participates in quality improvement efforts. 2. Top management sets the quality issues in the agenda of the managers' meetings. 3. Top management supports the quality improvement efforts by providing resources. 4. The quality policy is taken into consideration in strategic planning. 5. Quality data is taken into consideration in strategic planning. 6. The quality policy and objectives are communicated. 7. Top management gives the authority to employees to manage quality problems. 8. The company sets quality goals, objectives and strategies for managers and employees. 9. Quality performance and results are evaluated to check for improvements. 10. Top management gives priority to process and product/service design.
	Customer focus	1. There is a process of collecting customer complaints and suggestions. 2. Customers are encouraged to submit proposals for quality improvement 3. Customer complaints and proposals for quality improvement are selected. 4. Customers' needs, requirements, desires and expectations are recorded and analysed. 5. The company's managers or employees are in close contact with the customers.
	Employee management and involvement	1. Employees who improve quality are rewarded. 2. Employees are evaluated. 3. Employees participate in quality decisions. 4. Employees are motivated to improve their performance. 5. Employees participate in quality improvement activities. 6. Employees take initiatives during their work-problem solving process. 7. Employees implement changes. 8. Employees have the responsibility to provide quality. 9. Employees recognise superior quality performance. 10. Quality data are taken into consideration from employees during their daily work.
	Process quality management	1. Process and product nonconformities are detected through internal audits. 2. The points where time is lost are detected to minimise the cost of internal processes. 3. The critical processes are determined and evaluated. 4. Determination of areas, processes and points for improvement. 5. Specific organisational structure has been formulated to support quality improvement. 6. All employees are provided with work instructions. 7. Mistakes are precluded in the process design. 8. The processes are studied and improved. 9. Quality data are taken into consideration in the planning and control process.

Components	Dimensions	Indicators
	Employee knowledge and education	1. The educational programmes are evaluated for relevance. 2. The educational subjects are absorbed. 3. The employees have knowledge and know-how. 4. The employees are educated in subjects with regard to their speciality and daily work. 5. Employees are offered quality oriented training. 6. Employees are provided for educational reasons.
	Supplier quality management	1. Strategic partnership with suppliers.
	Information and analysis	1. Systematic recording and analysis of the organisation's performance data. 2. Systematic recording and analysis of the costs of the quality improvement initiatives. 3. Systematic recording and analysis of the quality data (rate of defects, defective products, non-conformities).
	Process and product quality design	1. The organisation is involved in design reviews. 2. An organisation makes clear product specifications.
TOTAL	**8**	**46**
Sustainability practices	Environment focused practices	1. Reduced food miles. 2. Energy efficiency and conservation. 3. Water efficiency and conservation. 4. Recycling. 5. Recyclable or biodegradable take-out containers. 6. Using eco-friendly cleaning products. 7. Composting.
	Food focused practices	1. Use of locally sourced ingredients. 2. Use of seasonal food. 3. Use of organic food. 4. Sustainably sourced food. 5. Animal welfare approved products. 6. More plant-based items, less animal-based food. 7. Reduction of processed food.
	Social sustainability	1. Involved in community activities. 2. Offer benefits to employees. 3. Contribute food to local charities.
TOTAL	**3**	**17**

ADDENDUM R: TOOL DEVELOPED AFTER PHASE 2

Components	Dimensions	Indicators
TQM Practices	Quality practices of top management	1. Management actively participates in quality management efforts. 2. Management holds regular meetings to discuss quality-related issues. 3. Management supports quality-improvement efforts by providing the necessary resources. 4. Quality data is taken into consideration in decision-making. 5. The quality policy is communicated throughout the company. 6. Top management gives employees the authority to manage quality problems.
	Customer focus	1. There is a documented process of collecting customer feedback. 2. Customers are encouraged to submit complaints and proposals for quality improvement. 3. Customer complaints and proposals for quality improvement are selected. 4. The organisation’s managers and employees are in close contact with the customers. 5. Customers’ needs, requirements and desires are recorded and analysed.
	Employee management and involvement	1. Employees who improve quality are rewarded. 2. Employees participate in quality improvement activities. 3. Employees take initiatives. 4. Employees recognise superior quality performance. 5. Employees are motivated to improve their performance.
	Process quality management	1. Process non-conformities are detected through internal audits. 2. Critical processes are determined and evaluated. 3. Determination of areas, processes and points for improvement. 4. Specific organisational structures have been formulated to support quality improvement. 5. All employees are provided with instructions.
	Employee knowledge and education	1. Employees are trained in subjects with regard to their specialty and daily work. 2. Employees have knowledge and know-how. 3. Employees are educated in quality management techniques.
	Supplier quality management	1. Adherence of the suppliers to food quality specifications. 2. Suppliers comply with requested food expiration dates. 3. Suppliers provide food quantities ordered. 4. Suppliers comply with the transportation standards for perishable and non-perishable foods. 5. Timely delivery of the food products by the suppliers. 6. Monitoring and assessing quality performance of the suppliers. 7. Open communication between the food service unit and the suppliers.
	Information and analysis	1. A variety of data collection methods are used to ensure reliability of quality performance data. 2. There is a systematic analysis of food quality data.

Components	Dimensions	Indicators
	Process and product quality design	***Purchasing*** 1. The expected amount of time is forecast before a food item should be purchased. 2. Food specifications are developed. 3. Units of measure are specified in the purchasing orders. 4. Particular expiration dates are requested when purchasing food items. 5. Only approved suppliers of food are selected. 6. Select and establish a variety of suppliers to ensure supply options.
		Receiving 1. There are scheduled hours for receiving. 2. Deliveries are inspected for quantity, against the purchase order and invoice. 3. Deliveries are inspected against the quality specifications. 4. Deliveries are checked to ensure undamaged packaging. 5. Expiration dates of deliveries are checked. 6. Temperature of perishable food is checked upon delivery. 7. Food items that do not meet quality specifications are rejected. 8. All newly received food items are date marked. 9. Received food items are promptly transferred to appropriate storage areas.
		Storage and inventory control 1. Storage areas have adequate dimensions for storing all food-related items. 2. Storage areas meet the specifications for walls, ceilings, floors, windows, baseboards, floor drains, lighting and ventilation. 3. Storage areas are regularly cleaned. 4. Storage areas have insect and rodent control. 5. Temperature of refrigerators is regularly checked. 6. Relative humidity of refrigerators is regularly checked. 7. Chemicals and cleaning agents are stored separately from food items. 8. The organisation of food items in storage areas prevents cross contamination. 9. The FIFO (First-In, First-Out) rotation system is applied at all times. 10. Expiration dates of food items are regularly checked. 11. Raw food is stored separately from cooked or ready-to-eat food. 12. Food is always kept covered. 13. A continuous track record is kept of food items held in storage.
		Issuing 1. A requisition form is used to issue food from storage to production. 2. Only the quantity of food needed, as specified on an authorised production record, is removed from storage. 3. Requested items are measured, using appropriate measuring equipment before being issued. 4. Food items issued are checked against standardised recipes before production. 5. Unused food is returned to the appropriate storage area.

Components	Dimensions	Indicators
		Production 1. Use of production schedules. 2. Ingredients are accurately measured with appropriate measuring equipment. 3. Food items requiring thawing are properly thawed. 4. Food is not exposed to the temperature danger zone for more than 4 hours. 5. Cooking temperature is properly controlled during production. 6. Food is cooked according to the appropriate cooking time. 7. Standardised recipes are adhered to during production. 8. Food is cooked to appropriate, stipulated quality standards. 9. Food is cooked to the appropriate internal temperature. 10. Food is evaluated for quality, prior to meal service. 11. An appropriate procedure is followed for chilling and freezing food.
		Distribution 1. An appropriate procedure is followed for reheating food. 2. Reheating is done in small batches. 3. Frozen food is reheated to the appropriate service temperature. 4. Sensory quality is retained during reheating. 5. Specialised equipment, with approved temperature controls, is used. 6. Food holding temperatures are monitored. 7. Proper equipment is used for distribution. 8. Temperature of food is properly controlled during distribution. 9. Time at which food is held while being distributed, is controlled.
		Service 1. Front-of-house staff check the quality of food before service. 2. Portions of food are verified upon receipt from back-of-house. 3. Bain-maries, chafing dishes and heated cabinets are at the correct temperatures. 4. Internal food temperature is measured and recorded. 5. An appropriate food temperature is maintained during service. 6. Food is kept covered until service. 7. Standardised serving utensils are used for portioning. 8. Portioning is done correctly. 9. Food is neatly plated and presented. 10. Leftovers are properly handled and stored. 11. The amount of time that the food is held at the temperature danger zone is highly controlled.
TOTAL	**8**	**97**

Components	Dimensions	Indicators
Sustainability practices	Environment focused practices	1. Less energy consumption methods. 2. Adherence to optimal cooking times. 3. Batch cooking. 4. Reduced food miles. 5. Limited use of running water. 6. Use of just enough water for food production.
	Food focused practices	1. Use locally sourced ingredients. 2. Use of food in season. 3. Use of organic foods. 4. Cook-to-order. 5. Use of leftovers. 6. Limited use of garnishes.
TOTAL	**2**	**12**

ADDENDUM S: TURNITIN RESULTS

An extract from the Turnitin report on the PhD thesis of Boineelo Pearl Lefadola

(18 August 2021).

The results of the Turnitin ‘Originality Report’.

PhD

ORIGINALITY REPORT

16%	15%	5%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS