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Improving canteen efficiency through business process improvement and facilities layout planning

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Executive Summary

A major retailer in Africa, Company X, has a distribution center working around the clock, to help grow the company's success. As expected, there are a multitude of workers employed at Company X's distribution center, all of which need meals during the day. One of the canteens, in particular, deals with concentrated, heavy flow of workers, at specific times of the day.

This research project's aim is to improve the canteen's efficiency through business process improvement and facilities layout planning.

The current scenario is analysed, simulated and the associated internal processes are depicted and analysed using business process diagrams. Thereafter, alternative layouts are developed and simulated (using Discrete Event Simulation (DES) modelling). The Systematic Layout Planning (SLP) method is used to develop the alternative layouts. The alternative layout's associated business processes are then also depicted, using principles of Business Process Model and Notation (BPMN).

In order to compare the various layout alternatives, based on different types of criteria, a technique called the Multi-Attribute Utility Theory (MAUT) is utilised.

General recommendations are made in order to address the inefficiencies that can not be addressed by the improved layout changes. The business processes of the implemented changes are also shown in a business process diagram.

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List of Abbreviations

ABS	Agent Based Simulation
ACO	Ant Colony Optimization
BPMN	Business Process Model and Notation
DES	Discrete Event Simulation
FLP	Facility Layout Planning
FM	Flowthing Model
MAUT	Multi-Attribute Utility Theory
MLP	Material Layout Planning
PUs	Process Units
SD	System Dynamics
SLP	Systematic Layout Planning
WIP	Work-In-Progress

Chapter 1

Introduction

1.1 Introduction

As a major retailer in Africa, Company X strives to address socio-economic challenges through the supply of high-quality, affordable food for all customers, while providing significant employment and economic opportunities across its value chain. The growth and success of Company X is attributable to three basic principles, which form the cornerstone of the business: Consumer sovereignty; Doing good is good business; and Maximising business efficiency (Anon, nd).

Contributing towards the maximisation of business efficiency, is ensuring the efficiency and wellness of their workers, in their distribution center. Two canteens located on the plant, enable workers to maintain their energy levels by having their meals served to them on the doorstep of their workplace.

One of the canteens, in particular, handle concentrated, heavy flow of workers and, unfortunately, its current layout and business processes are contributing to the congestion. The focus of this project will be to improve canteen efficiency through business process improvement and facilities layout planning.

According to Becker (1981), facilities are entities which can be influenced, changed, and used for the better of organisations. Seen in this perspective, the design of facilities' layouts can give a facilities manager an opportunity to influence the performance of organisations. Fitzsimmons and Fitzsimmons (2006) also state that "facilities can have an important influence on service operations, for instance, on the behaviour and satisfaction of customers, queuing systems, and sales".

For these reasons, the first step in achieving the ultimate goal of improving the efficiency of the canteen, is to improve the facility's layout.

Secondly, the newly recommended layout will have its own internal processes associated with it. It is important to keep in mind that one does not want to complicate the internal processes of the canteen, to the extent that the staff members become estranged to it. This is why business process simplicity and improvement will be taken into account.

1.2 Research Problem

Company X's canteen experiences a heavy flow of traffic at specific times of the day, such as breakfast-, lunch- and dinner times. Queuing times for workers are extremely long and cause dissatisfaction. In Company X's canteen there are numerous inefficiencies, which may be caused by various factors. Possible factors may be poor business processes, the lack of resources, inappropriate utilization of the available resources and/or an inefficient layout. Resources that may be lacking, include canteen staff and/or clean plates for customers to dish up. Major inefficiencies include long queuing- and system times, with workers even sometimes queuing outside of the canteen area. These inefficiencies contribute in a large way to the congestion the canteen experiences. From the possible factors causing these inefficiencies it is decided that by foremostly addressing the inefficient layout, it might already minimize a number of these inefficiencies.

This project thus aims to develop a more suitable layout for the canteen, assess the simplicity of the processes associated with the layout, and lastly, make general recommendations, in order to ultimately produce a more efficient canteen environment.

This project's problem is solved by answering the following research question: How can Company X's canteen efficiency improve through business process improvement and facilities layout planning?

1.3 Research Design

1.3.1 Research Objectives

This project aims to create a more efficient canteen environment for Company X. The project aims to achieve this, by firstly focusing on developing a more efficient facility layout for the canteen, and secondly considering the canteen staff's processes. After physically studying the canteen, it is believed that most inefficiencies present in the canteen, can be addressed by following this method. Before developing the alternative facility layouts, the current layout is analysed to identify where bottlenecks are present and what elements increase the inefficiencies of the canteen. After developing the alternative layouts, its associated business processes are depicted using a business process diagram. The layouts are then assessed according to the chosen criteria, to see if the efficiency of the canteen has been improved. The most efficient layout (according to the chosen criteria) is selected as the recommended layout for the canteen.

1.3.2 Project Deliverables

To assist in answering the research question, a simulation model is developed, initially to visualize the as-is situation. Secondly, it is developed to compare alternative solutions on certain criteria and ultimately, to select the best suitable solution. Of course, the alternative simulation models are based on alternative layouts, which are also developed as deliverables. In order to consider the simplicity of each alternative's processes, each process will be mapped and analysed. This will also be included as a criteria when selecting the best suitable layout. General recommendations are also made when inefficiencies are identified outside of the facility layout solution's scope.

1.3.3 Research Assumptions and Limitations

The focus of this project is simply on the flow of the workers from the moment they enter the canteen serving area (queue to be served), until they exit the system. This serving area will also be referred to as the canteen environment, as this will be the main focus of the project.

An assumption that is taken into account in this project, is that the canteen environment stays the same through all three meal times.

Budget constraints for the implementation of the most efficient layout, found in this project, are not taken into consideration. Also, the human factor of unwillingness to change the layout, from Company X's side, is not taken into account. What will however be taken into account, is the practical limitation of moving the kitchen area.

Constraints in this project, includes the confidentiality agreement, of not being able to use Company X's real name in any documentation made public.

1.4 Research Methodology

The first step in answering the research question, is analysing the current layout of the canteen, in order to identify where the inefficiencies and their possible causes are present. This step is completed by physically studying the canteen environment and its layout and doing time studies. Time studies are done on queuing times of workers, arrival rates and service times. It is also important to identify the bottlenecks and constraints (amount of service stations, physical doors or walls) that cause queuing times to increase.

Resources are also accounted for, for example, the amount of canteen staff available to assist the workers (who are customers in this case). Their working schedules are taken into account, to ensure that these resources are available when needed.

The current layout is then simulated in an agent-based model, using AnyLogic software.

Secondly, alternative layouts are developed in order to minimise the inefficiencies. The alternative layouts are then also simulated in order to compare the resulting queuing times of the different alternatives.

Thirdly, the alternative layouts' processes are mapped (using principles of BPMN) and the simplicity of the processes are compared.

Based on the criteria selected, the most suitable solution will be selected.

Minimum queuing time is chosen as criteria for the efficiency of the layout, as it is felt that the canteen should be an environment for the workers to receive their meals as quickly as possible in order for them to relax after a long working shift at Company X. Thus, the shorter the queuing time, the less frustrating the process of receiving their meals will be.

The simplicity of the layouts' processes is chosen as a criteria for the efficiency of the layout, as it is important not to complicate the internal processes of the canteen to the extent that the staff members are estranged with their own environment.

Cost will also be considered as a criteria, as this will always be a consideration for management as to whether or not to implement a change in their company.

Since the simulation models will be responsible to produce the queuing times, these times (and the arrival rates) that are captured from the current situation, are used as model validation for this as-is scenario.

1.5 Document Structure

Chapter two in this document includes literature reviews with the purpose of selecting the best process and facility planning techniques, for developing alternative layouts for the canteen. Literature is also reviewed in order to choose the best method of visualising and comparing the current and alternative layouts. The process mapping approach that will be followed, is also reviewed in chapter two.

Chapter three includes the current layout, its processes and the base case simulation model. Developed solutions of improved alternative layouts, their processes and simulation models follow in chapter four. Chapter five contains the result analysis and general recommendations on improving the canteen's efficiency.

Chapter 2

Literature Review

2.1 Introduction

According to Becker (1981), facilities are entities which can be influenced, changed, and used for the better of organisations. Seen in this perspective, the design of facilities' layouts can give a facilities manager an opportunity to influence the performance of organisations. Facilities can also have an important influence on service operations, for instance, on the behaviour and satisfaction of customers, queuing systems, and sales (Fitzsimmons and Fitzsimmons, 2006)

Looking at time constraints during labourers' breaks, in South Africa, "workers must have a meal break of 60 minutes after 5 hours of work. A written agreement may: reduce meal intervals to 30 minutes, or eliminate meal intervals for workers who work less than 6 hours a day" (Law, 2002).

Since the workers at Company X work more than 6 hours a day, a 60 minute break, or if otherwise agreed upon, a 30 minute break will be required.

Given the time limitations of office canteen customers and their need to relax, it is pre-supposed that, especially these customers, may have a general desire to minimise their waiting period (Underhill, 1999). Apart from the quality of products and services to be delivered in an office canteen, the speed of operations may therefore be an important performance objective for facilities managers. It is yet, however, unknown to what extent the facility layout of an office canteen can influence the behaviour of customers and how this influences the efficiency of operations (Zijlstra and Mobach, 2011).

2.2 Dutch Office Canteen Study

De Zwart (2000) states that: "An office canteen may be regarded as a place where specialized staff provides restorative services within a company or for a company in terms of food and beverages". Apart from a satisfactory meal, customers of canteens also seek cognitive-emotional satisfaction (Kim and Moon, 2009).

Zijlstra and Mobach (2011) investigate the influence of an office canteen layout on operations, specifically on customer behaviour before checkout, waiting times, and congestion. In this study, two Dutch office canteens were selected based on their motivation to participate in the study.

In Zijlstra and Mobach (2011), the canteen layout is designed as a self-service environment. The essential characteristic of a self-service environment, is that customers can pick their own food and drinks.

With direct observations, the behaviour, waiting times, and congestion of 47 customers were analysed. Customer behaviour was reported qualitatively, waiting times and congestion were reported quantitatively.

Results from the study indicated that canteens where customers can move freely before a checkout queue, allow them to move away from congestion, towards food products. This type of canteen also seem to have more favourable waiting times, than customers in canteens with layouts requiring a strict order and line-up for self-service and checkout (Zijlstra and Mobach, 2011).

This specific characteristic of a self-service environment, is one that, unfortunately, does not resemble the current situation at Company X. In the canteen environment at Company X, there are canteen staff that dish-up for the workers. This setup, can unfortunately not be so easily altered as the canteen staff are instructed to dish-up only a certain amount of each food type per serving. Thus, it will not be allowed for the workers to dish-up for themselves.

Although the layout, where workers will be able to move freely, will not be possible in Company X's case, it is an important note to take for future reference. It will be useful to keep in mind if Company X decides, in future, to change their canteen environment and the way food is being served in the environment. Also, this study once again highlights how important it is to decrease the waiting time in the canteen environment as it is even more undesired than in normal circumstances. This study also emphasised the important influence that facilities and the design and management thereof, have on the organisation and its employees.

After it was found that the office canteen in Zijlstra and Mobach (2011), does not resemble the situation at Company X, the layout of a buffet restaurant was researched. This was done in order to find specific facilities planning techniques, that had already been tried and tested in a similar situation as Company X's office canteen.

2.3 Buffet Restaurant Study

Lee et al. (2013) focus on a design support model for improving the service efficiency of restaurant layout, but unfortunately the article focuses on how restaurant staff move around in the restaurant, serving customers, and also how the customers will then move from their tables, to the buffet and back. Once again, the customers (workers in the case of Company X) and staff of Company X, do not move in the same way as modelled in this article.

Nevertheless, the near-optimal layout solution for the buffet restaurant was found by using a simulation software, called VISSIM. Based on the results of the simulation model, the total moving time of the occupants (staff and customers) of each layout, could be calculated. The total moving time values was then entered into the Ant Colony Optimization (ACO) mechanism and used for comparing the quality between layout solutions (Lee et al., 2013).

Although the setup of the buffet restaurant is not at all the same as the office canteen at Company X, Lee et al. (2013) once again explain how useful simulation modelling can be when searching for the optimal facility layout. Lee et al. (2013) explain that it is quite difficult to evaluate the performance of layout solutions through on site relocation of services and facilities, because it requires a huge amount of human labour, time and cost. For designers, it is almost impossible to try multiple layout portfolios on site.

After thorough research on similar facility layouts, a specific facilities planning technique, that had already proven to be suitable for direct application to this particular canteen environment, was not clear. Thus, more general techniques were researched to determine the best process to develop alternative layouts for the canteen.

2.4 Facilities Planning Techniques

According to Tompkins et al. (2010), most facility layouts can be viewed at two levels: The block layout (which shows the location, shape, and size of each planning department) and the detailed layout (which shows the exact location of all equipment, work benches and storage areas within each department). For a facility layout to be complete and effective, both the block layout (macro) and the detailed layout (micro) need to be developed and evaluated carefully.

When asked which comes first, the block or detailed layout, Tompkins et al. (2010) recommend that basic requirements for each department (such as space requirements and shape constraints) are obtained first and then a set of alternative block layouts must be developed.

Before developing alternative layouts, it is critical to identify the right number and types of departments that will be used to populate the layout.

Consequently, this is one of the first tasks that will be performed - identifying the right number and type of departments and obtaining space and shape requirements of each department.

Layout procedures (of developing layout alternatives) can be classified into two main categories: construction type and improvement type. Construction layout methods involve developing a new layout from nothing. Improvement procedures, on the other hand, generate layout alternatives by seeking improvements in an existing layout (Tompkins et al., 2010).

This project will thus be working with an improvement procedure, as the canteen is already erected.

According to Gilbert (2004), SLP is a highly used methodology, especially in small- to mid-size companies, due to its accessibility.

Tompkins et al. (2010) provide a diagram of Murther's SLP Procedure in Figure 2.1.

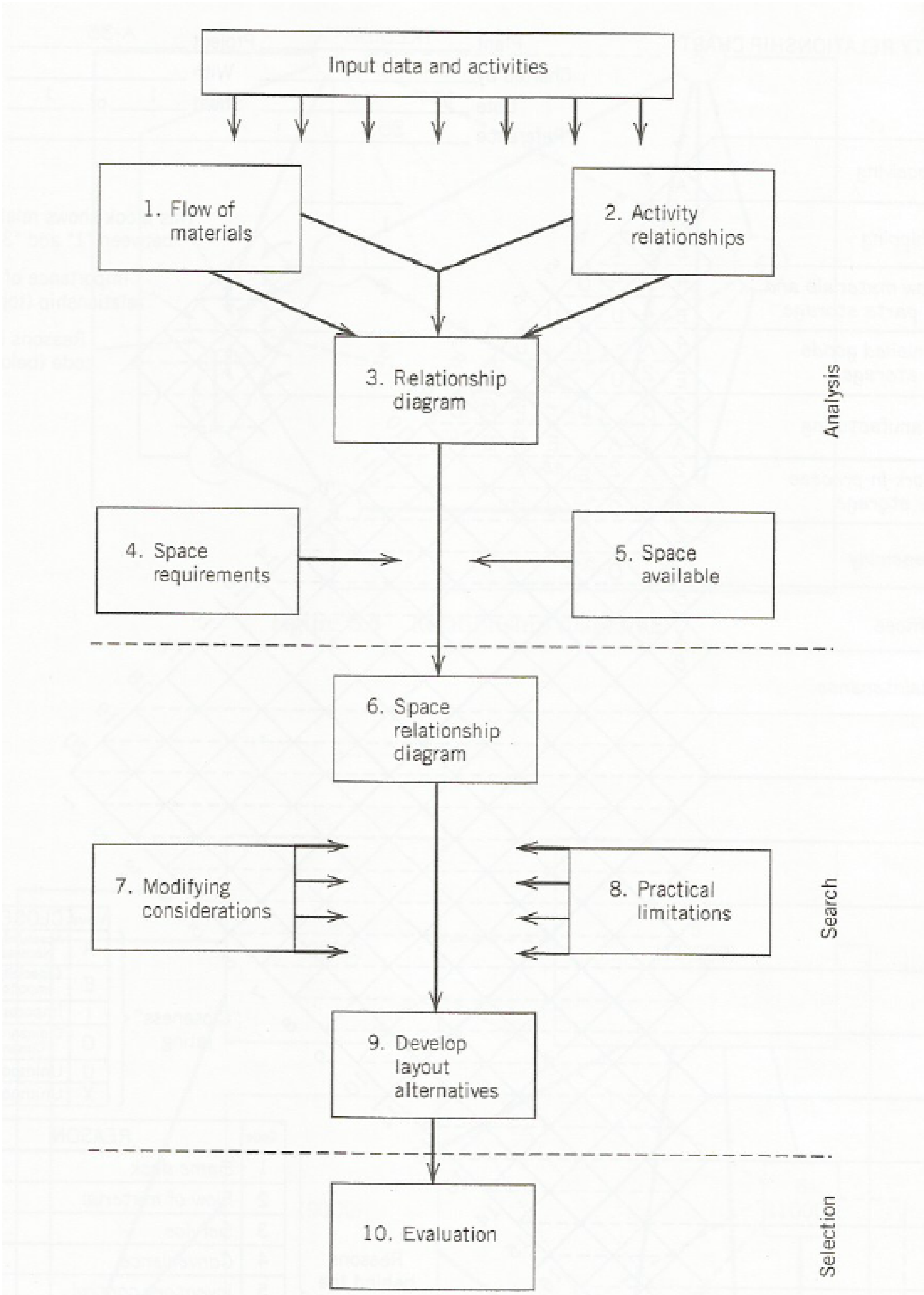

Figure 2.1: Systematic Layout Planning (SLP) procedure

As seen in Figure 2.1, the first step in the SLP procedure is to perform a material flow analysis (from-to chart) and an activity relationship analysis (activity relationship chart). This will be done based on the input data and an understanding of the roles and relationships between activities (Tompkins et al., 2010).

From the analysis performed, a relationship diagram is developed. The relationship diagram positions activities spatially (Tompkins et al., 2010).

The next two steps involve the determination of the amount of space to be assigned to each activity. Once this has been done, space templates are developed for each planning department and a space relationship diagram is obtained (Tompkins et al., 2010).

Based on modifying considerations and practical limitations, a number of layout alterations are developed and evaluated. The preferred alternative is then identified and recommended (Tompkins et al., 2010).

Tompkins et al. (2010) explain that, ”the conversion of a space relationship diagram into several feasible layout alternatives, is not a mechanical process: intuition, judgment, and experience are important ingredients in the process”.

2.4.1 Case Study in a Southern Brazilian Restaurant

Flessas et al. (2015) aims to apply the SLP method in the kitchen of a small southern Brazilian restaurant in order to analyse the production and information flow, formulate layout alternatives and then, suggest a better physical distribution of its processes.

Once again pointing out the importance of a facility's layout, Slack et al. (2002) state that a layout is one of the most important characteristics of a productive operation, because it determines the ”shape” and appearance of its environment. Bougoure and Lee (2009) also explain that changing the way these environments are organised, directly influences the way processes flow, which evidences the importance of a good layout for business performance.

Tortorella and Fogliatto (2008) further explain that SLP has three macro steps: (i) analysis, (ii) research and (iii) selection (which confirms what has been displayed in Figure 2.1 from Tompkins et al. (2010)) .

Flessas et al. (2015) start the SLP process by collecting qualitative and quantitative data related to the current scenario, in order to comprehend the restaurant production process and the system constraints, such as production demand, area, material flow and employees (J.A. Tompkins and Tanchoco, 1996). During this step, professionals involved in the kitchen were interviewed.

In the second step, the material flow is analysed and the relationship intensity among the PUs is quantified, so the required proximity is respected and prioritised during the layout development (Flessas et al., 2015).

An example of the Activity Relationship Chart is shown in Figure 2.2 (Flessas et al., 2015).

	PUs	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Asepsis sink													
2	Bin 1	5												
3	Bin 2	0	X											
4	R1	0	0	0										
5	R2	0	0	0	0									
6	R3	0	0	0	0	0								
7	Salads	0	1	5	5	9	9							
8	F1	0	0	0	3	3	3	1						
9	Custom. meals	1	1	5	3	9	1	1	1					
10	Buffet	1	5	1	5	9	5	5	1	1				
11	Washing	0	9	0	0	0	0	1	0	5	5			
12	Grill	0	X	X	X	X	X	0	X	9	5	0		
13	Stove	0	X	X	X	X	X	5	X	9	9	0	9	

Proximity relationship	
9	Absolutely important
5	Especially important
3	Important
1	Regular proximity
0	Not important
X	Undesirable

Figure 2.2: Activity Relationship Chart

Step three includes the practical limitations of the facility (Flessas et al., 2015). These may include departments that cannot be moved because of the difficulty and cost of the implementations.

In step four, the PUs are defined and classified according to the three main groups in the restaurant's kitchen: health and hygiene, food storage and production processing (Flessas et al., 2015). Several layout alternatives are developed and their operation performance are evaluated and ranked according to the pre-defined criteria in step five.

In the last step Flessas et al. (2015) use the Multi-Attribute Utility Theory (MAUT) (Neto, nd), which provides a multi-criteria assessment for all layout alternatives previously generated. This is done in order to select the best overall alternative.

Figure 2.3 provides an example of the MAUT technique (Flessas et al., 2015).

Criteria	Indicators	Weight	Altern. 1	Altern. 2	Altern. 3
People	Work-related accidents	15	7	10	10
Process	Productivity	20	7	14	15
	Traveled distances	15	5	10	15
	WIP	15	10	10	15
Financial	Operating costs impact	10	15	10	3
Market	Order waiting time	30	10	10	17
Total		105	920	1.130	1.440

Figure 2.3: Multi-Attribute Utility Theory (MAUT)

The task of assigning weights to criteria, requires the involvement of the senior management in the selection process, since they will indicate the most important indicators to the business (Reynolds and

McClusky, 2013; Hwang and Ko, 2003).

The analysis in Flessas et al. (2015) focussed on the most critical period, the dinner service, since it offers both customised meals and a buffet service.

The order waiting time was considered the indicator of greatest importance, because it directly affects customer satisfaction.

A 20-point continuous scale was used, zero being a much lower performance than shown by the current layout, and 20 as the maximum score, such that the expected performance is much higher than the current one. The layout alternative score was the weighted sum of each indicator score (Flessas et al., 2015).

In this case, multi-criteria analysis resulted in the third alternative being chosen as the best layout for this restaurant kitchen (Figure 2.3).

The results from the implementation of this layout involved a reduction in Work-In-Progress (WIP) and the displacements of the cooking assistants were minimised, the access of the oven, stove and grill was simplified. This directly contributed to the increase in staff productivity, besides better production area utilization (Flessas et al., 2015).

In this case study of the southern Brazilian restaurant, it is evident that the layout of a facility has a direct impact on the operations that takes place within that environment. This case study also confirms that SLP is a method that can effectively help one comprehend the operations and limitations of a facility's layout, develop and assess alternative layouts and, ultimately, recommend the best alternative layout.

The MAUT technique is also a valuable tool presented by Flessas et al. (2015). This multi-criteria analysis will thus be used to analyse and ultimately select the most suitable layout for Company X's canteen.

Although Flessas et al. (2015) chose work-related accidents, productivity, travelled distances, WIP, operating costs impact and order waiting time as their indicators, this project considers other indicators that are more relevant to Company X's canteen. Indicators that are rather considered as indicators are queuing time, simplicity of associated processes and costs.

Since a facilities planning technique was found to develop alternative layouts for the canteen, a tool could now be chosen to visualise and compare the various layouts.

2.5 Simulation

2.5.1 Material and Facility Planning in Construction Projects

In Pejman Alanjari (2014), simulation is used for material and facility layout planning in a construction project. Layout planning for construction projects comprises of two tasks: Facility Layout Planning (FLP) and Material Layout Planning (MLP). These two tasks has significant impacts on project cost and time. FLP specifies where to position temporary facilities on the site, and the position of the material in the storage yard, is determined by MLP (Pejman Alanjari, 2014).

Pejman Alanjari (2014) focus on MLP and describe a simulation-based method to improve material yard layout. In this method, simulation is employed for modelling the material handling process in order to evaluate the material handling time.

They state that: "The location of facilities influences different aspects of construction projects such as equipment, worker and material transportation time and cost, safety and environmental issues, and accessibility." Maximising safety and minimising transportation time or cost are the major objectives in FLP (Pejman Alanjari, 2014).

FLP can become a complicated process when objectives, such as the latter, are conflicting and influencing factors are interdependent. Thus, to predict the efficiency of the facility layout plan in real world construction processes, a more sophisticated approach is needed (Pejman Alanjari, 2014). Pejman Alanjari (2014) state that "simulation can address this, due to its capability to model the complexity of construction operations and dynamic interactions of various factors. It can model the impact of facility layout on construction operations, and examine the efficiency of the facility layout in practice with a certain level of confidence".

Similar to FLP, the layout proposed from simulation methods can be of great assistance in MLP (Pejman Alanjari, 2014).

Pejman Alanjari (2014) found that simulation is capable of modelling the complex interaction between resources, measuring their utilization, waiting time and idle time, which are key components in determining the material handling time. This feature makes simulation superior to commonly-used methods such as optimizing the sum of weighted distance function (which was initially used).

Pejman Alanjari (2014) once again highlight the significant influence a facility's layout has on any project's operations. They also explained why simulation is superior to other methods when visualising and comparing different layout solutions.

While Pejman Alanjari (2014) focus on FLP and MLP, this project's main concern will be Company X's canteen facility layout and business processes. The major objectives in FLP, in construction projects, are maximising safety and minimising transportation time and/or cost. While this is true for construction projects, the main objectives for the canteen's facility layout is minimising the queueing time for the workers and improving the business processes in the canteen environment.

2.5.2 Chosen Visualisation and Comparison Tool

The tool chosen to visualise and compare current and alternative layouts for this project, is simulation modelling. Simulation modelling was chosen, as it provides a valuable tool for approximating real life behaviour and can thus be used for testing scenarios. Also, the modeller may come to understand the real system to a greater extent, when constructing the model (Maidstone, 2012).

When it comes to simulation modelling, there are three main approaches: DES, Agent Based Simulation (ABS) and System Dynamics (SD). Before deciding which approach is best suited for this project, their basic definitions were investigated and comparisons were made.

According to Maidstone (2012), DES models a process as a series of discrete events. This means that entities (workers in this case) move between different states as time passes. The entities enter the system and visit some of the states (not necessarily only once) before leaving the system.

Maidstone (2012) explains that SD takes a slightly different approach to DES, as it focuses more on flows around networks than on the individual behaviour of entities.

While SD tends to take a more overall perspective (macroscopic), DES tends to look at the smaller detail of a system (microscopic).

ABS, according to AnyLogic (nd), from a viewpoint of practical application, can be defined as a decentralised, individual-centric (as opposed to system level) approach to model design.

While, at first, SD and ABS systems seems to be very different from one another, the Agency Theorem for System Dynamics (Macal, 2010) states that every well formulated SD model has an equivalent formulation as an ABS model. This tends to produce results which perform at least as well as running the SD model, if not better. However, ABS models requires more time to model and run (Maidstone, 2012). Also whilst ABS is stochastic, SD models tend to be deterministic.

In comparing ABS and DES models, there are two main differences to be noted. Firstly, in ABS systems the agents each have their own behaviour and hence are classed as "active". In contrast, the behaviour of the entities in a DES model is determined by the system and these are thus classed as "passive". Another key difference is that while DES is built around networks of queues, there is no concept of queues in an ABS system (Maidstone, 2012). Despite their differences, both models are stochastic in nature and can use input distributions to model random behaviour.

After careful consideration, it was decided that DES modelling would be best suited for this project, as the focus of the model would be to simulate the "passive" workers as they progress through the system, as time passes.

AnyLogic, a simulation software, supports DES (as well as ABS and SD) and allows one to efficiently combine it with other modelling approaches. For this reason, the DES model will be simulated using AnyLogic software.

2.6 Business Process Model and Notation (BPMN)

As mentioned in chapter one, the first step in this project is to analyse and improve the facility's layout. The method of executing this step and the tool used to visualise the layouts, are researched in the previous sections.

Secondly, the alternative layouts developed have business processes associated with them. It is important to ensure that these processes are kept as simple and efficient as possible. For this reason, the focus of the literature review is now shifted to the business process analysis and improvement.

Business Process Model and Notation (BPMN) is a popular process modelling standard and graphical representation specifying business processes (White, 2008). According to Wei Wu (2015), it offers simple, but standardized visual communication for users to understand the external and internal business procedures through a business process diagram.

A typical BPMN process has clearly defined business goal(s), the process input and output, the responsible parties, tasks or sub-processes and the information exchange. Processes may occur sequentially or concurrently, or sometimes will reiterate (Wei Wu, 2015).

Wei Wu (2015) states that Microsoft Visio provides built-in BPMN templates and notations to streamline the mapping efforts. This eases the development of the various business process diagrams for this project.

2.6.1 Office Workflow Case Study

Al-Fedaghi (2014) focuses on the problem presented by Abouzaid et al. (2011) in a design utilizing BPMN for an office workflow case study. BPMN was selected for comparison with Flowthing Model (FM), because of its wide adoption as a standard for business process modelling (Al-Fedaghi, 2014).

It was found that the structure of the FM representation reflects a map of the system. By contrast, the BPMN depiction has a prevailing "control flow" distinction that reflects, in general, the network (sequence) of tasks to be performed (Al-Fedaghi, 2014).

This is ultimately what this project wants to depict by the business process analysis - the network of tasks of the staff at Company X's canteen.

For these reasons, principles of BPMN is utilised to visualise and analyse the business processes of Company X's canteen.

2.7 Concluding Remarks

Through all literature reviewed and case studies read, it is evident how important the layout of a facility remains to be, and the direct impact it has on the operations taking place within the facility.

A Dutch office canteen study was reviewed, and although the canteen described in Zijlstra and Mobach (2011) does not resemble the situation at Company X, it was interesting to note how canteen customer behaviour can change as a result of free movement in their environment. Zijlstra and Mobach (2011) also, once again, stressed the importance of decreasing queuing time in a canteen environment. Waiting time in a canteen environment is even more undesired than in normal circumstances.

A buffet restaurant study was also reviewed, but again the setup of this study does not resemble Company X's canteen environment. What was quite important of this study, is that Lee et al. (2013) highlighted how useful simulation modelling can be when searching for the optimal facility layout.

At last, an appropriate facilities planning technique was found and described in Tompkins et al. (2010). The SLP procedure was confirmed being useful and recommended by Flessas et al. (2015), in the case study on a Southern Brazilian restaurant. A multi-criteria assessment technique, Multi-Attribute Utility Theory (MAUT) was also described and this project consequently uses this technique in the final step of the SLP process.

Pejman Alanjari (2014) was then reviewed and the tool chosen to visualise and compare the various developed alternative layouts' output, was simulation modelling. More specifically, discrete event simulation modelling using AnyLogic software.

Finally, Business Process Model and Notation (BPMN) was researched and principles of BPMN is consequently utilised to visualise and analyse the business processes of Company X's canteen.

Chapter 3

Current Scenario

3.1 Current Layout

The current scenario was analysed and the service area's stations were physically measured in order to accurately draw up the current layout in the MS Visio software.

Figure 3.1 represents the as-is situation at Company X's canteen.

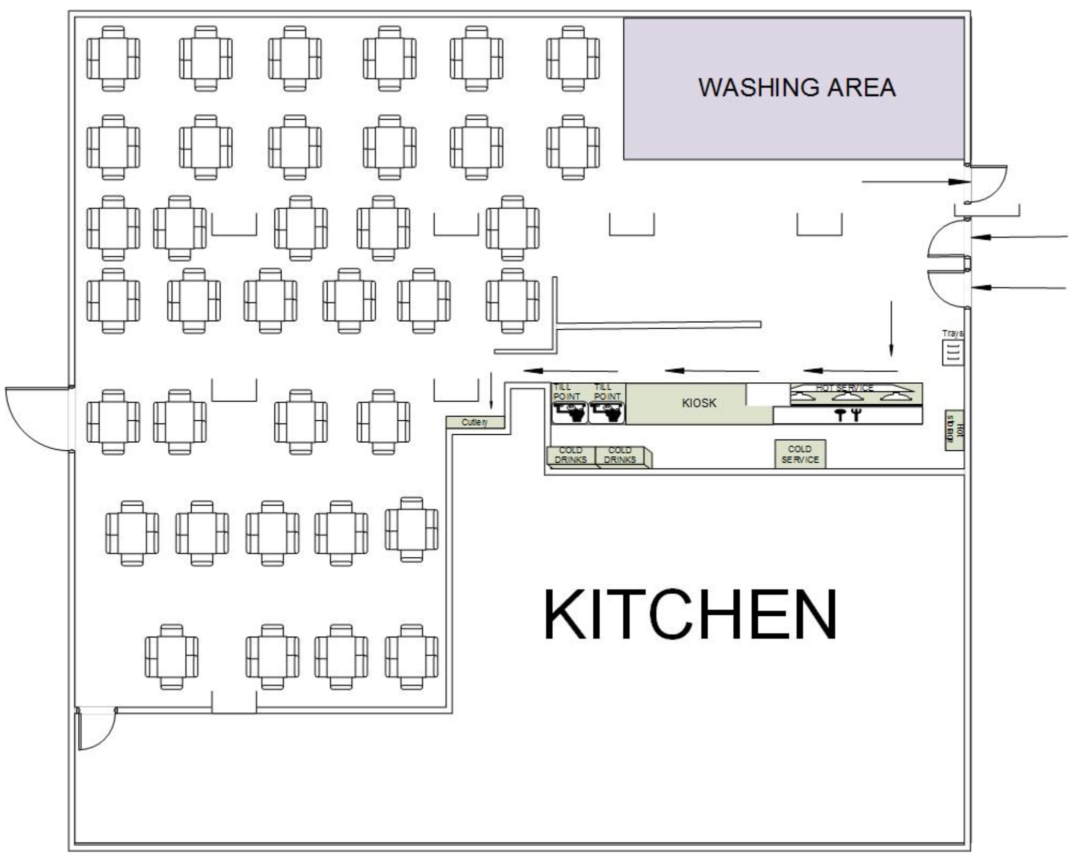

Figure 3.1: Current Layout

Since the service area is a minor part of the total area of the canteen, Figure 3.2 shows a clearer view of this area.

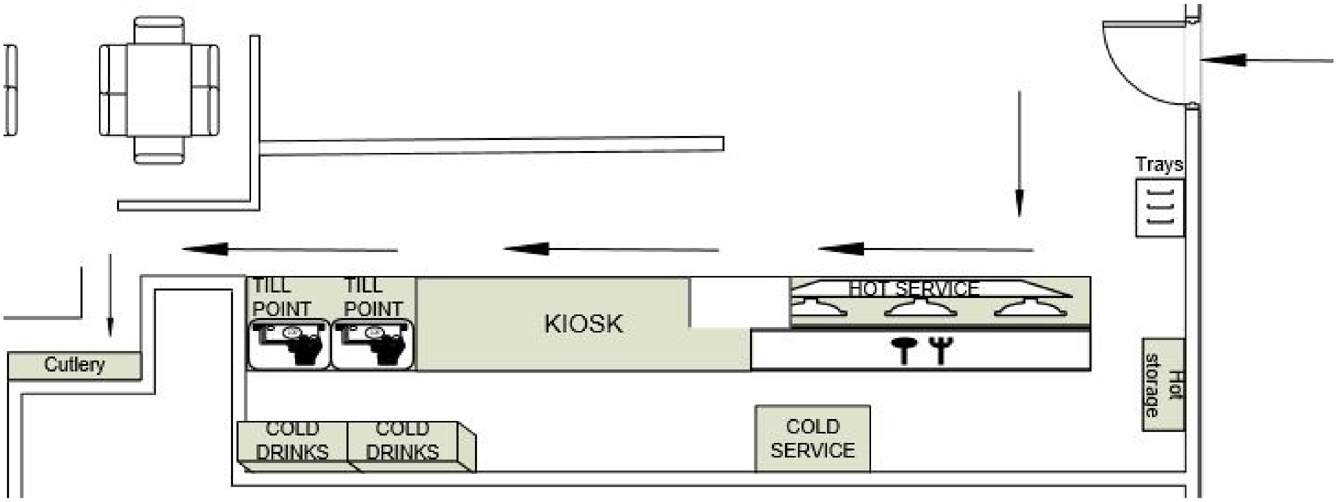

Figure 3.2: Current Layout - Service Area

3.2 Current Process and Process Mapping

As indicated in Figure 3.1, the workers enter the canteen via the double door on the right. After entering the canteen, the workers follow the flow as indicated by the arrows in Figure 3.1. Figure 3.1 indicates the four main service stations, namely the hot service station, cold service station, the kiosk and the till point. Before arriving at the hot service, workers collect a tray for their plate and other purchases. When the payment is complete at the till point, workers collect their cutlery on the left hand side, whereafter they find a seat to enjoy their meal.

Currently, there are two sales ladies working at the till points and kiosk and three other staff members serving at the hot- and cold service stations, collectively. Two of these three staff members, that serve at the hot- and cold service stations, are also the head cooks.

Currently there are 200 plates available for all workers arriving at their different time periods. For example, there are 200 plates available for the 600 workers arriving in the 10:00 to 14:00 slot. After the workers have eaten their meals, they place their trays and plates on a trolley nearest to them. These trolleys are then collected by one of the two staff members, from the washing area, that wash the plates. The plates are unloaded to the washing area and the trolley with the remaining trays on them, are taken back to the original tray stand at the hot service area. The trays are then unloaded onto the original tray stand and the trolley (that brought the clean plates) is taken back to the area where the workers have their meals.

Business process diagrams are drawn in order to visually perceive the current internal process of the main service stations. Although the hot- and cold service stations were identified as two separate service stations, they are combined in the business process diagrams and also in the simulation models to come, as it is observed that there is no distinction made between the two stations. The three staff members also work collectively between the two stations.

Figure 3.3 illustrates the business process diagram of the current layout's serving area.

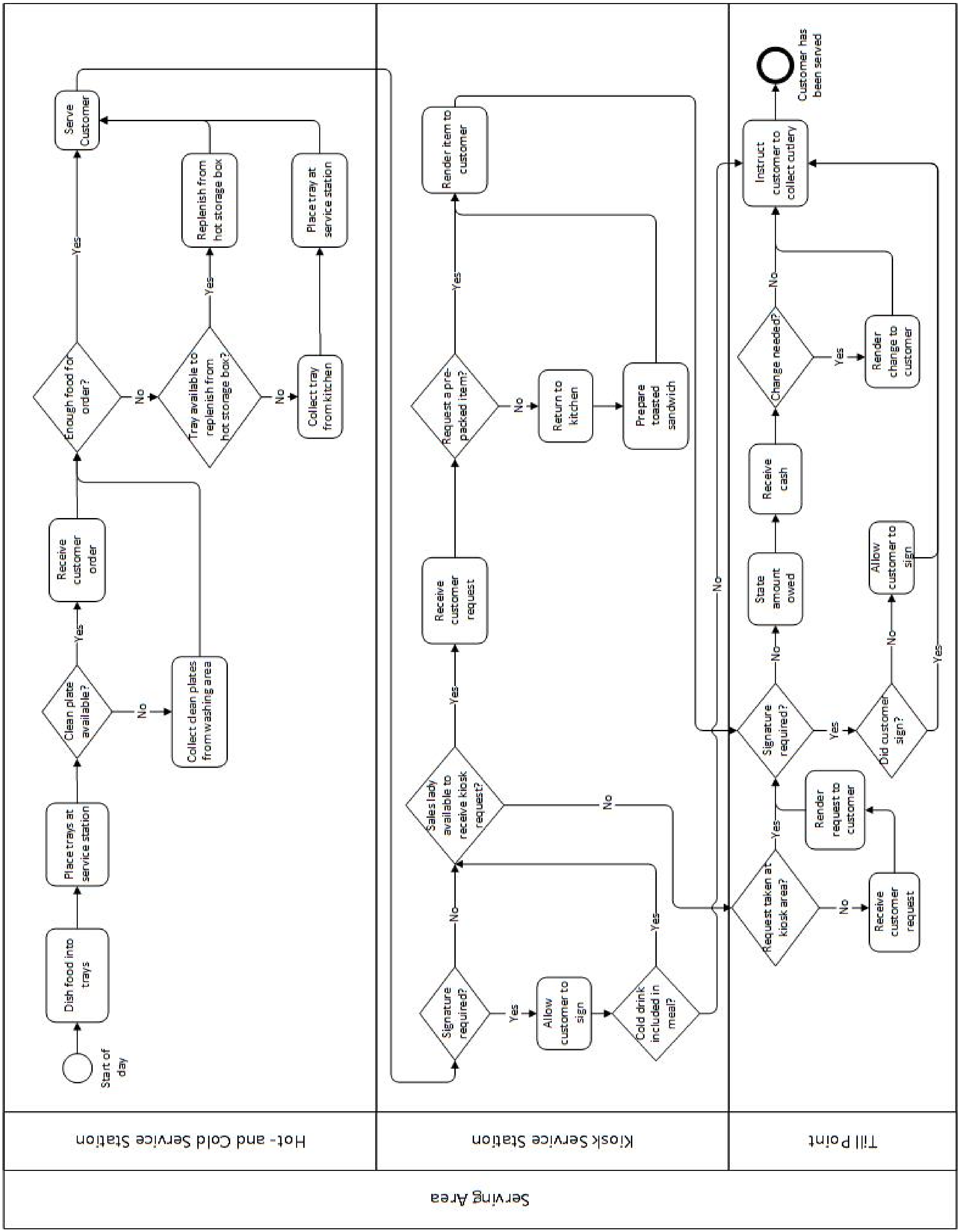

Figure 3.3: Business Process Diagram - Current Layout Serving Area

As mentioned above, there are three staff members working at the hot- and cold service station. Two of these three are head cooks in the canteen's kitchen.

At the start of the day the cooks dish the food into the trays that are placed at the service station and in the hot storage box, respectively. When the customers arrive, the server has to observe whether or not there are enough clean plates. If there are, the server may receive the customer's order, if not, the server must collect the available clean plates from the washing area.

The server must then observe whether or not the available food, is sufficient for the customer's order. If there is, the server may serve the customer. If not, the server must then perceive whether or not there is a tray available to replenish, from the hot storage box. If there is, the server may replenish the tray and serve the customer. If not the server must collect a tray of food from the kitchen and then only serve the customer.

When the servers have served the customer, the customer moves to the kiosk area. The sales lady working at the kiosk service station, also makes the sandwiches and salads. Consequently, she is not always available.

Nonetheless, when the customer arrives at the kiosk area and the customer needs only to sign for his/her meal, the customer can do so, since the signature list lies on the counter of the kiosk area. If this customer's meal includes a cold drink, the kiosk's sales lady may take the customer's request. If the lady is not available, the customer will have to submit his/her request at the till point only.

If the customer pays with cash for the meal, and has a kiosk request, the same procedure is applicable as was for the customer mentioned above.

If the sales lady is available at the kiosk service station, the lady must discern if the request is a pre-packed item or if it is a sandwich, that still has to be prepared. A pre-packed item may immediately be rendered to the customer, while the lady will have to return to the kitchen and prepare a sandwich.

At the till point the sales lady will have to ensure that the customer's kiosk request was taken at the kiosk. If not, the lady may then take the customer's request and react accordingly. If the customer has indeed received his/her request, the lady must discern if the customer has to sign for his food and drink, and it he/she has already done so or not. If the customer has signed, the sales lady must instruct the customer to collect his/her cutlery. If not, the lady may allow the customer to sign and then also instruct the customer to collect his/her cutlery.

If the customer pays with cash for his/her food and drink, the lady may state the amount due, receive the cash and render change to the customer if needed.

Figure 3.4 illustrates the business process diagram of the current layout's washing area.

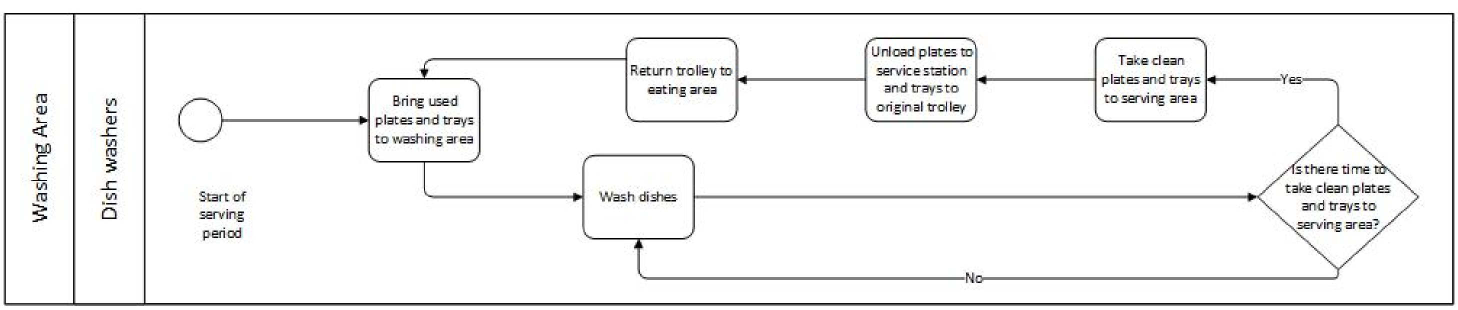

Figure 3.4: Business Process Diagram - Current Layout Washing Area

As mentioned at the beginning of this section, when the workers have consumed their meals, they place their trays and plates on a trolley nearest to them. These trolleys are then collected by one of the two dish washers (staff). The plates are then washed. The dish washers have to then make the decision whether one of them have time to take the clean plates and trays back to the serving area. If he/she does, he/she may do so and return the trolley to the eating area. If neither of them do, they will carry on washing the dishes.

3.3 Current Inefficiencies

Various inefficiencies have been identified in the as-is situation:

- Through interviews, it was found that the major problem that canteen staff are experiencing, is the intense, heavy flow of workers that arrive in a matter of a few hours. Currently, the canteen staff prepare and serve about 200 to 250 breakfasts between 7:30 and 9:30, 600 lunches between 10:00 and 14:00, 150 meals between 17:00 and 18:30. The meals between 17:00 and 18:30 are for workers not necessarily working in the distribution area, for example truck drivers. 600 suppers are served between 17:00 and 02:00. All meals are identical throughout the day, except the breakfasts.

- The major problem that canteen customers (workers of Company X) are experiencing, is the time they spend queuing before they may collect their meals.

- Through interviews, the insufficiency of space to queue seems like a problem, but in actual fact it may simply be the lack of facilitated flow of the workers that causes the supposed lack of space. Also, if the queuing time can be decreased, there will be less workers crowding the same space.

- There are currently three to four cooks running the kitchen per day. This means that, the two head cooks, that are busy serving the workers at the hot- and cold service stations, must regularly return to the kitchen to make sure that everything is still in order.

- The hot service station holds approximately 50 portions of what is served on the day. Next to the hot- and cold services, there are two hot boxes in which the cooks are able to store extra trays of hot food. These trays also contain more or less 50 portions. Even though this is convenient having 50 extra portions in arm's reach, if there are 600 workers coming through the service area, those 50 portions are replenished very quickly (especially during the peak period at 12:00). This also causes the cooks (and service staff) to have to return to the kitchen to collect the next set of trays of hot food.

- Through observation followed by interviews, one of the great causes for the queue to pile up before the hot service counter, is the lack of clean plates for the workers to receive their food on. There are numerous times where the canteen staff are ready to serve the workers, but there are no clean plates to allow this. Intuitively, this event occurs especially in the canteen's peak period (12:00) as there are more workers arriving at that period, thus the plates get used at a higher rate. This frequently causes one of the hot service staff to walk to the washing area, to see whether there are clean plates available and ready for collection. Most of the time the service staff member that makes these trips, is one of the head cooks that also serve at the hot- and cold service. This results in that person actually having three responsibilities at the same time. Because of this, and the other head cook also having to return to kitchen regularly, it happens more often than not, that at their busiest time (e.g. 12:00), there remains only one staff member serving workers at the hot- and cold service. This immediately contributes to the queue increasing.

  Also, for a staff member to go fetch the plates, he has to move through all the workers queuing in front of the hot- and cold service and then back again, to place the plates at the beginning of the hot- and cold service area. This is uncomfortable for both parties and also poses the risk of letting the plates fall, when the staff member tries to navigate his way between the workers, while carrying the plates in his hands.

- The washing area (indicated in Figure 3.1), where the dirty plates are brought to be washed, takes up a very large space in comparison with the canteen service area. Also, through observation, it was noted that the only equipment and people operating in that area are; two washing basins, a dishwasher (which is not in use) and two staff members washing the dirty plates. The dishwasher is not in use, as it takes too long to wash the dishes before clean plates are required at the service area. Therefore, it can be concluded that the washing area's space may well be altered, in order to create more space for the workers (customers) to move between the washing area and service area.

- As seen at the end of the service counter, there are two till points next to one another. Currently, only one till point is being used. The remaining sales person assists the workers, by fetching cold drinks and other kiosk items that they may request. This is done as a security measure. When both ladies are busy at the tills, it is seen as a risk for some of the workers to slip past, without them paying. By having one of the ladies helping at the kiosk area, she is able to supervise the area. Unfortunately, this leaves one resource (till point) unutilised.

- Another factor that causes increased time at the till point and kiosk, is the fact that some workers have to sign a list instead of paying with cash at the till point. Currently, this list lies on the counter top of the kiosk area. The sales lady that assists at the kiosk area then indicates to the workers that have to sign the list, to sign. This is done in order for those workers not to queue up to the till point, since they don't need any change from the till. The only problem with this system, is that the workers that have to pay with cash at the till point, are then held up at the kiosk, where there are various workers waiting to sign the list. The workers that have to pay at the till point can't see past the person in front of him, and consequently they don't pass the workers signing at the kiosk area, as they think that they are all in the same queue towards the till point. In busy times this even causes a build-up of the queue at the hot- and cold service stations.

- The two sales ladies working at the kiosk and till point, include a full time teller and the second lady (kiosk assistant) also makes the salads (for the cold service) and sandwiches (per kiosk request). This means that the second lady is not always available to help at the kiosk area. Consequently, the workers ask for certain kiosk items only on arrival at the till point. This increases the time spent at the till point and increases the queue towards the till point. For this reason, the till point and kiosk area is perceived as one service station in the current simulation model, as generally, there is no distinction for the worker between the two stations.

- Another inefficiency, is the fact that workers that solely want to purchase an item at the kiosk, simply jump the line, which also causes the queue to the till point, to increase. At first, this seemed to be a big problem, but in the interviews it was discovered that there are maybe 30 workers, out of an entire meal period (600 workers), that has the need to only visit the kiosk. So, although this remains a problem worth attempting to solve, this is not the main focus for developing alternative layouts.

- The small space in which all the workers must collect their cutlery, seems to be something that may be improved as well.

3.4 Base Case Simulation

The base case simulation is displayed in Figure 3.5.

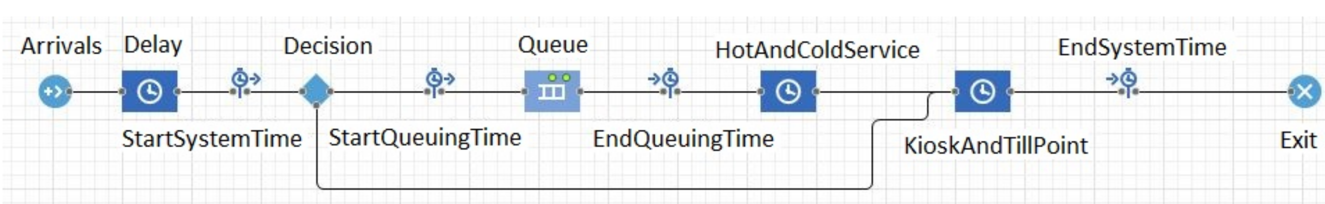

Figure 3.5: Current Layout Simulation

An explanation of Figure 3.5 follows here:

1. Arrivals:
   This block generates the workers as they enter the canteen. The arrival rate is set to a geometric distribution, with the continuous success probability (p) equal to 0.26271. This resulted from the time studies executed at the canteen. The arrival rate is given in arrivals per minute. See Figure B.1 in Appendix B.1 for the graph of the data captured and fitted distribution.

2. Delay:
   The Delay block is simply a very small time delay to enable the simulation model to process the large amount of arrivals into the system, in such a short time period.

3. StartQueueingTime and EndQueuingTime:
   The StartQueueingTime and EndQueueingTime blocks are used to measure the time from the point where the workers enter the queue, up to the point where they arrive at the hot service area. This is described as they queueing time of the system.

4. StartSystemTime and EndSystemTime:
   The StartSystemTime and EndSystemTime blocks are used to measure the time from the point where the workers enter the queue, up to the point where they have paid at the till point. In this scenario, it is described as the system time.

5. Queue:
   This block represents the queue of the workers.

6. Decision:
   This block represents the decision a worker has to make in terms of wanting to visit the hot- and cold services, kiosk and till point, or only wanting to visit the kiosk and till point. The probability of a worker only wanting to visit the kiosk, is estimated at 0.05 percent. This estimation was made based on an interview with the canteen manager. Currently, the workers that only want to visit the kiosk skips the queue to the hot- and cold service, and directly join the queue at the kiosk service area. Through physically studying the current layout, this observation is made.

7. HotAndColdService, KioskAndTillPoint:
   These delays represent the time the worker spends at each of these PUs. Because of the staff members serving at the hot- and cold service stations collectively, these two PUs are simulated as one station. Also, as a result of the workers mainly asking for their kiosk items at the till point, the kiosk and the till point are simulated as one station. The hot- and cold service delay is set to a lognormal distribution, with the following parameters; the mean of the included normal (mu) equal to 4.3266, standard deviation of the included normal (sigma) equal to 0.482 and the minimum being equal to 1.322. While the kiosk and till point service delay is set to a weibull distribution, with the following parameters; shape parameter (alpha) equal to 2.0969, scale parameter (beta) equal to 109.41 and the minimum x value being equal to 17. These values are results of time studies executed at the canteen. All service delay times are given in seconds. See Figure B.2 and Figure B.3 in Appendix B.2 and B.3, for the graphs of the data captured and fitted distributions.

8. Exit:
   This block disposes of the workers after they have been served.

3.4.1 Results

The simulation is run 50 times, the mean queuing time for each iteration is then captured and analysed.

Figure 3.6 shows the data captured from the simulation model and the fitted distribution.

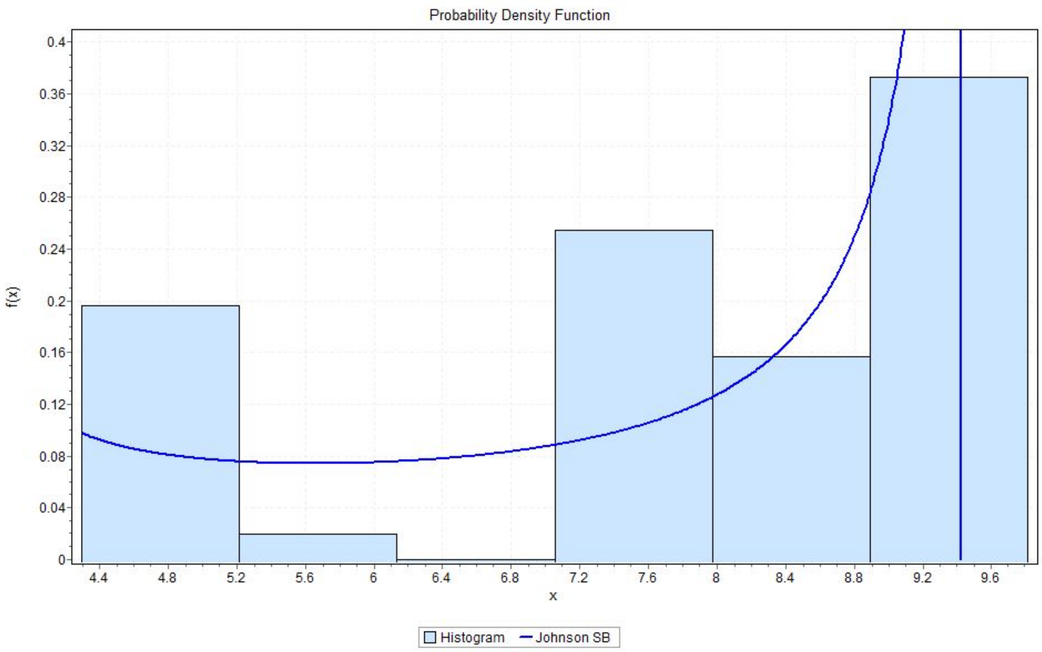

Figure 3.6: Current Simulation's Queuing Time and Fitted Distribution

The resulting queuing times of this current layout is found to be given by a Johnson SB (system bounded) distribution, with the following parameters; real numbers gamma (shape parameter) equal to -0.64674 and zeta (location parameter) equal to 3.8403, and positive real numbers delta (shape parameter) equal to 0.37966 and lambda (scale parameter) equal to 5.5834 (all given in minutes). This means that the probability of the queuing time being greater than 3.5 minutes, is 100 per cent. Alternatively, the probability of the queuing time being larger than eight minutes, is 59.47 per cent.

3.4.2 Model Validation

To be able to still validate the base case simulation model, the arrival rate and the queuing time data that were gathered (during the time studies) are used.

The output of the EndQueuingTime block, except for the usual statistics, also includes a table which shows the amount of workers that share the same queuing time. Figure 3.7 may explain this better:

EndQueueingTIme

root.EndQueueingTIme: TimeMeasureEnd
in: 567
out: 567
Time distribution:
Count 567
Mean 550.706
Min 0
Max 1,059.335
Deviation 296.724
Mean confidence 24.424
Sum 312,250.403

From	To	PDF(hits)	CDF(cum hits)
0	76.8	28	28
76.8	153.6	29	57
153.6	230.4	44	101
230.4	307.2	46	147
307.2	384	43	190
384	460.8	47	237
460.8	537.6	38	275
537.6	614.4	45	320
614.4	691.2	42	362
691.2	768	42	404
768	844.8	44	448
844.8	921.6	40	488
921.6	998.4	42	530
998.4	1,075.2	37	567

Figure 3.7: EndQueuingTime Block Output

Note that the results of the EndQueuingTime block are given in seconds, not minutes. This is done in this way, in order to ensure accuracy when analysing each iteration's data and converting to minutes.

After viewing a few of the EndQueuingTime block outputs, it is found that this data corresponds with the queuing times in a specific time period and the number of workers arriving in that same time period, in the actual as-is situation.

Table 3.1 shows a summary of the model validation in a more visual manner.

Number of Workers	Average Actual Queuing Time (minutes)	Output Queuing Time (minutes)
Highest	7.38	6.4 - 7.68
Lowest	0.31	0 - 1.28

Table 3.1: Model Validation

Originally the model was thought to be validated by using the queuing times of the as-is situation that were captured, during the time studies. The captured queuing times were to be fitted to a distribution and compared with the queuing time results, from the current layout's simulation. Unfortunately, due to time - and resource constraints, sufficient data could not be gathered. The above methodology was then found to be a good alternative way of validating the model.

3.5 Concluding Remarks

In this chapter, a relatively accurate representation of Company X's present canteen layout was drawn up in the MS Visio software. The current process was described and depicted using a business process diagram.

Various inefficiencies were observed and the importance of many of them was then established through interviews. The base case simulation model was also developed and explained in this chapter. After the results from the simulation model were captured, it was analysed and given in the form of a Johnson SB (system bounded) distribution, with the following parameters; real numbers gamma (shape parameter) equal to -0.64674 and zeta (location parameter) equal to 3.8403, and positive real numbers delta (shape parameter) equal to 0.37966 and lambda (scale parameter) equal to 5.5834. This means that the probability of the queuing time being greater than 3.5 minutes, is 100 per cent. Alternatively, the probability of the queuing time being larger than eight minutes, is 59.47 per cent.

To be able to validate the base case simulation model, the arrival rate and the queuing time data that were gathered (during the time studies) were used. After viewing a few of the EndQueuingTime block outputs, it was found that this data corresponds with the queuing times in a specific time period and the amount of workers arriving in that same time period, in the actual as-is situation.

Chapter 4

Solution Development and Analysis

By following the steps of the Systematic Layout Planning (SLP) process, alternative layouts are developed.

Step 1: From-To Chart

A From-To chart is generally applicable in cases where a product is produced and parts flow from one department to another in order to complete the product. The From-To chart is useful to observe the equivalent flow from one department to the next.

In this scenario, it is not parts, but people that flow from one process unit to the next. Another difference is that the amount of people that flow from the first process unit to the next, does not differ from one another as the flow is unidirectional and the people in the flow line do not increase and decrease.

Thus, it is found to be non-value adding to develop this chart.

Step 2: Analysis of Flow of People and Relational Intensities

An Activity Relationship Chart is developed in order to measure the flows qualitatively (Figure 4.1).

	Process Unit	1	2	3	4
1	Hot service				
2	Cold service	5			
3	Kiosk	1	1		
4	Till point	3	3	5	

	Proximity Relationship
5	Especially important
3	Important
1	Regular proximity
0	Not important
X	Undesirable

Figure 4.1: Activity Relationship Chart

The relationships between the hot- and cold service and the kiosk and the till point are ranked the most important according to Figure 4.1. Cold service must always follow the hot service PU, as both these PUs include products that are included in a meal combination.

A till point must always follow the kiosk, as customers do not visit any other PU after the kiosk, except the till point.

Although the till point doesn't have to follow the hot- and cold services immediately, it is important that they be in near proximity to each other. The customer will have to visit the till point shortly after the hot- and cold services.

The kiosk should preferably be in regular proximity to the hot- and cold services, but it is not as critical as the other relationships.

Step 3: Practical Limitations Assessment
The main practical limitation that should be kept in mind when developing alternatives, includes the degree of difficulty and cost that would be required to move the kitchen.

Another practical limitation that needs to be taken into account, is the space available behind the counter. In other words, a large number of staff can't be employed to lessen the load, without considering whether there will be enough space for the staff to move in.

The rate at which the workers arrive at the canteen, cannot be dispersed more evenly, as Company X has strict working shifts it has to keep to, in order to effectively distribute its products.

Step 4: Layout Alternative Development
When reconsidering the layout, it is necessary to carefully consider each PU's area to ensure that there will be enough space for relocation (Flessas et al., 2015). Table 4.1 provides this information.

Process Units	Length (m)	Width (m)	Area (m^2)
Hot service	3.70	1.02	3.774
Cold service	1.15	0.76	0.874
Kiosk	3.70	1.02	3.774
Till point	1.80	1.02	1.836

Table 4.1: Area of PUs

What is important to note here, is that the kiosk area sell individual items. Thus, the kiosk's area is not set, but can be changed by the way these items are displayed and packed on the counter.

Taking this information into account, two improved layout alternatives are developed.

4.1 Alternative Layout 1

Figure 4.2 shows the layout alternative number one.

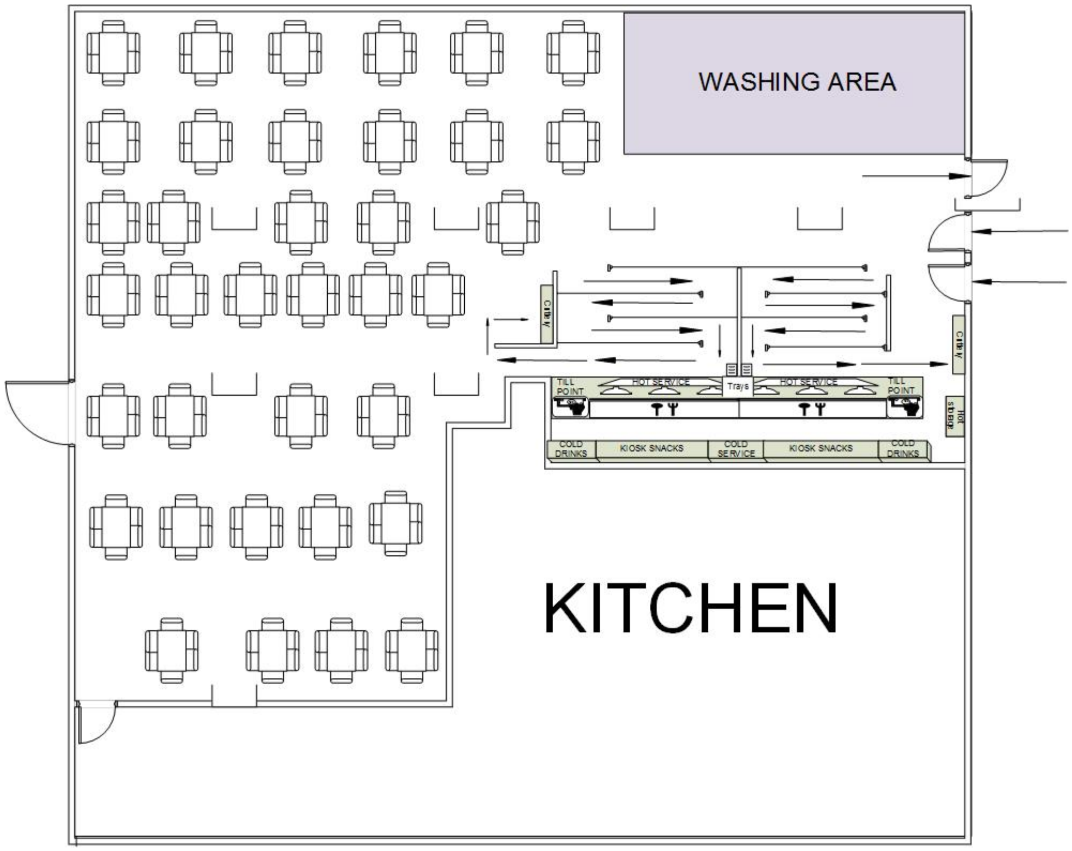

Figure 4.2: Alternative Layout 1

Once again, a clearer view is provided of the service area in Figure 4.3.

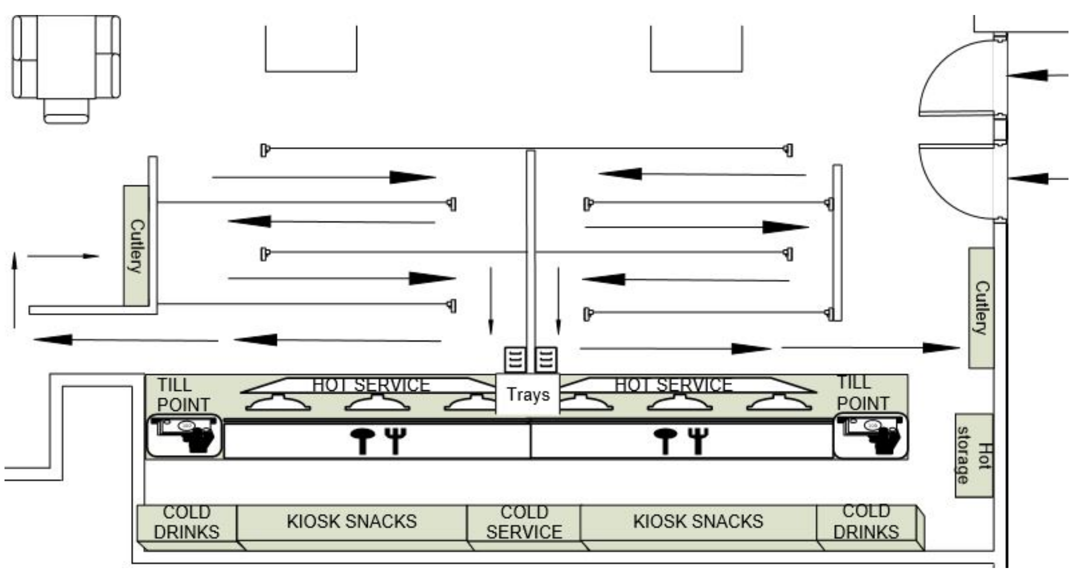

Figure 4.3: Alternative Layout 1 - Service Area

In this improved layout the main focus is to facilitate better flow of the workers queuing and attempting to decrease the queuing time. This is done by making hot- and cold service stations and till points available on either side of the service area. There are also two tray stands and two different locations available for workers to collect their cutlery.

This layout will, however, require more staff at the service counter. There will be twice as many hot- and cold service stations (three staff members each) and also twice as many till points and kiosk areas (two staff members each). Where the current layout required at least five staff members at the service counter, this layout will require at least ten.

4.1.1 Alternative Layout 1 Process Mapping

Figure 4.4 illustrates the business process diagram of alternative layout 1's serving area.

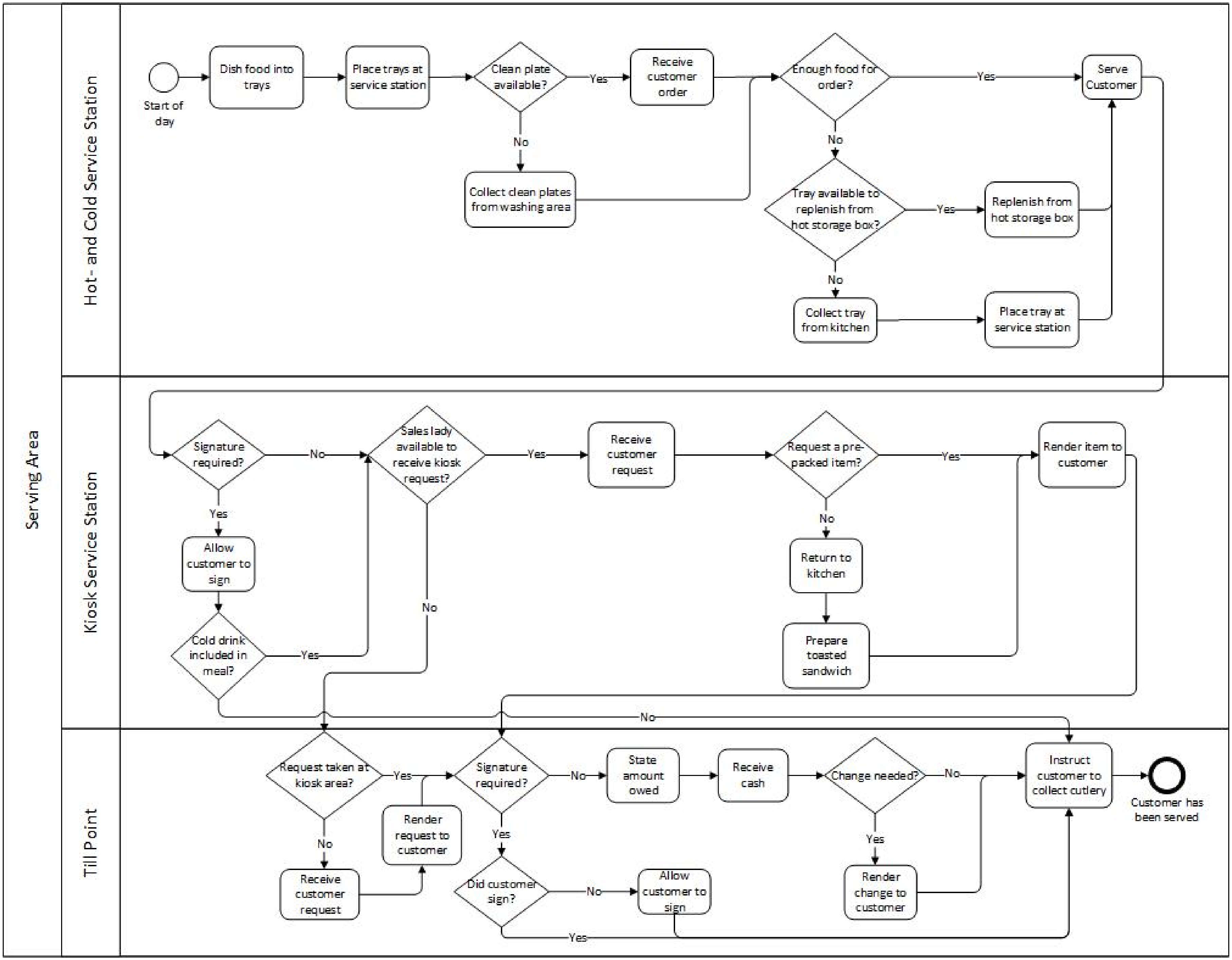

Figure 4.4: Business Process Diagram - Alternative Layout 1

Since the focus in this improved layout was mainly to facilitate the flow of the workers queuing and attempting to decrease the queuing time, the internal operations of the canteen staff do not differ from the current layout's operations. The workers being served, will be most affected by the changes made. The business process diagram of alternative layout 1 is thus identical to that of the current layout.

4.2 Alternative Layout 2

Figure 4.5 shows the alternative layout 2.

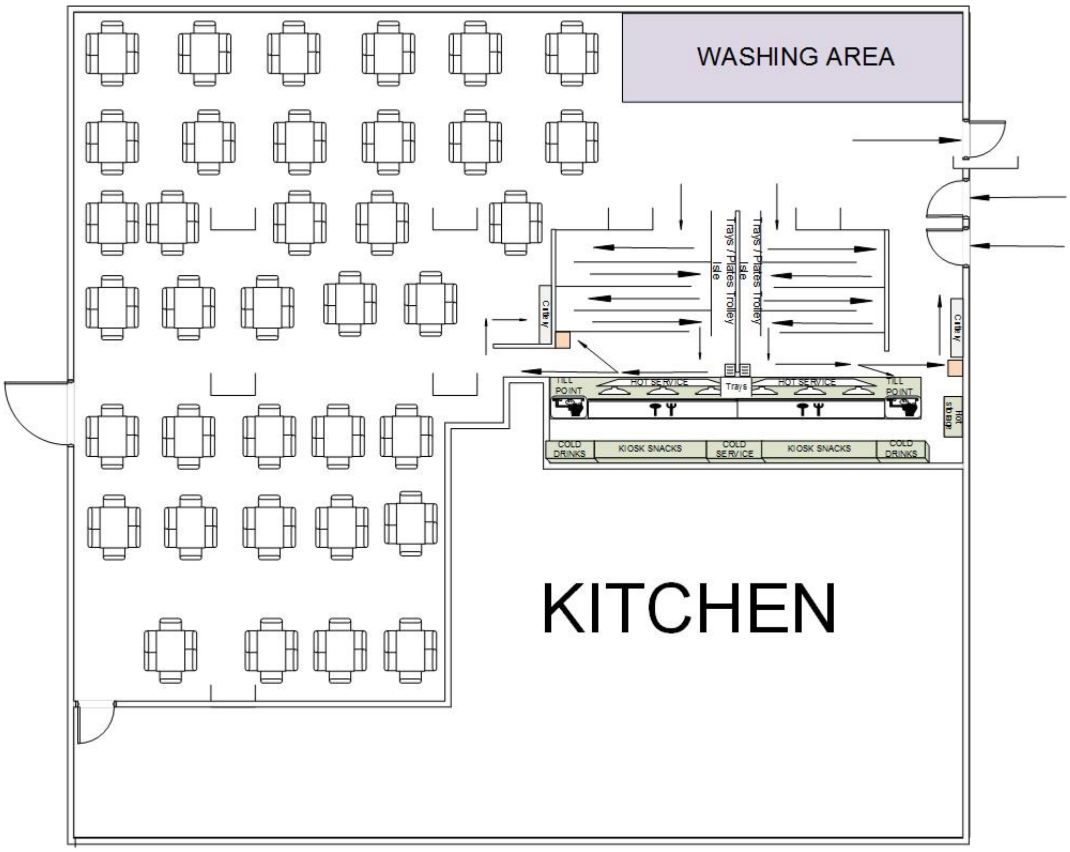

Figure 4.5: Alternative Layout 2

A clearer view is provided of the service area in Figure 4.6.

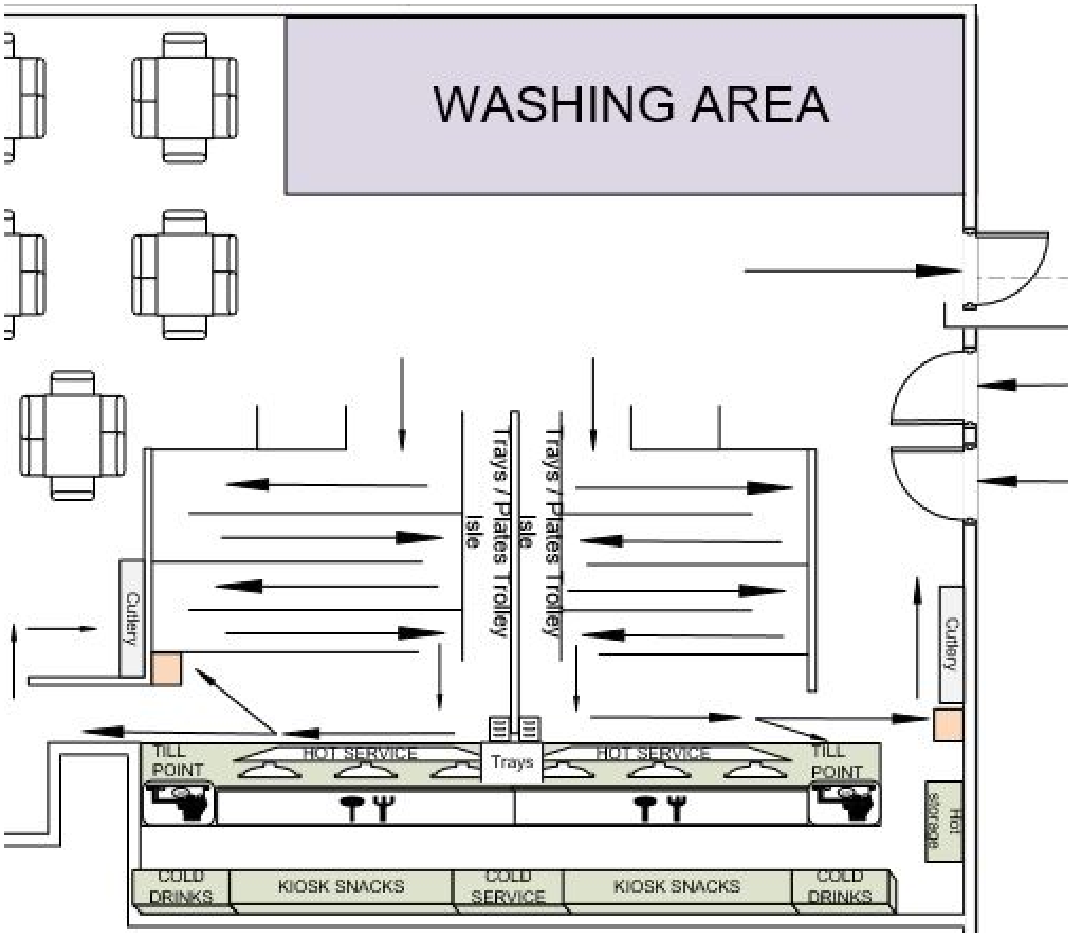

Figure 4.6: Alternative Layout 2 - Service- and Washing Area

In this second alternative layout, the focus is to address as many of the inefficiencies, identified in the current situation, as possible. This is attempted by:

1. To solve the major problem of the heavy flow of workers that arrive within a short period, the same idea of splitting the load into two, as in alternative layout number one, is used.

2. The flow of the workers are also addressed again by directing the workers into a certain queue shape. This shape is also enlarged in this alternative to give the workers more space to queue and hopefully also decrease their discomfort of queuing. One can notice this as the queue dividers are moved back to the pillars between the service area and the washing area.

3. The problem of the staff member having to move through all the workers in front of the hot service station, is addressed by creating a lane between the two queues, which is reserved to staff members bringing plates to the service area. This lane also provides an easier way for the staff member having to unload the trays onto the tray stands at the service area.

4. The surface area of the washing area is also decreased as this area does not necessitate the total current surface area. This is also done in order to create a larger space for the workers entering and exiting the canteen area.

5. The problem of the two different paying methods, namely signing the list or paying with cash at the till point, is also addressed in this layout alternative. This is done by having a small table across from each till point, respectively, where the list will be located for the workers to sign. These tables

can be seen in Figure 4.6 as the light brown squares. Of course, this will require a staff member facilitating this process at each table. In other words, two extra staff members.

6. Again, there also two different locations where the workers may collect their cutlery.

4.2.1 Alternative Layout 2 Process Mapping

Figure 4.7 illustrates the business process diagram of alternative layout 2's serving area.

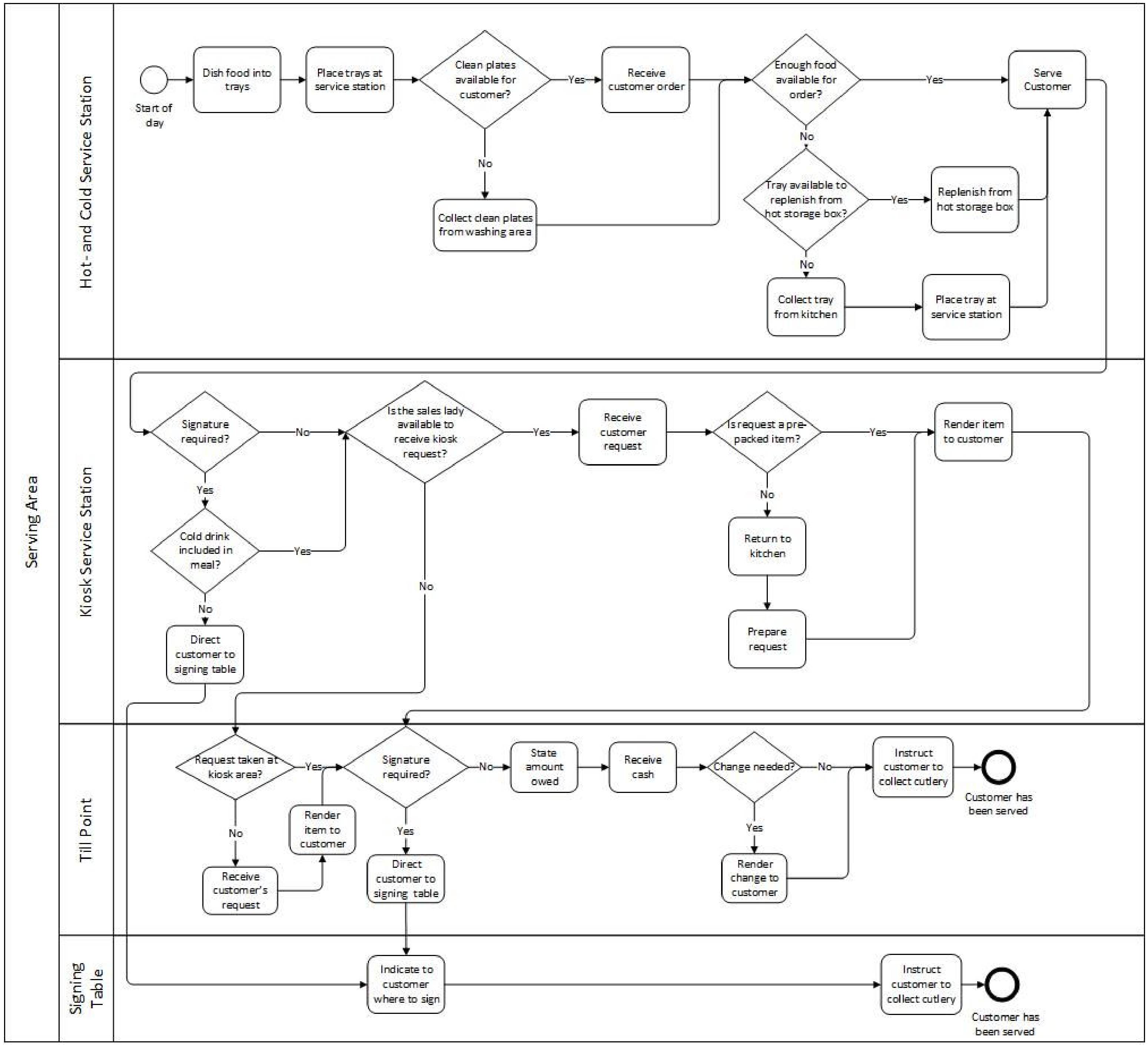

Figure 4.7: Business Process Diagram - Alternative Layout 2

The internal processes of the hot- and cold service station, is identical to those of the current and alternative layout 1's.

As soon as the servers have served the customer, the customer moves to the kiosk area. As mentioned before, the sales lady working at the kiosk service station, also makes the sandwiches and salads. Consequently, she is not always available.

Nonetheless, the customer arrives at the kiosk area. If the customer needs only to sign for his/her meal, the customer is now importantly directed toward the signing table. This is what differentiates alternative 2 from the other layout alternatives. At the signing table there will be a staff member that indicates to the customer where to sign and ultimately instructs the customer to collect his/her cutlery.

If this customer's meal includes a cold drink, the kiosk's sales lady may take the customer's request. If the lady is not available, the customer will have to submit his/her request at the till point only.

If a customer pays with cash for the meal, and has a kiosk request, the same procedure is applicable as it was for the previously mentioned customer.

If the sales lady is available at the kiosk service station, the lady must discern if the request is a pre-packed item or if it is a sandwich, which still has to be prepared. A pre-packed item may immediately be rendered to the customer, while the lady will have to return to the kitchen and prepare a sandwich.

At the till point the sales lady will have to ensure that the customer's kiosk request was taken at the kiosk. If not, the lady may then take the customer's request and react accordingly. If the customer has indeed received his/her request, the lady must discern if the customer has to sign for his food and drink, and if he/she has already done so or not. If the customer has signed, the sales lady must instruct the customer to collect his/her cutlery. If not, the lady may direct the customer to the signing table. The staff member at that table will then indicate to the customer where to sign and ultimately instruct the customer to collect his/her cutlery.

If the customer pays with cash for his/her food and drink, the lady may state the amount owed, receive the cash and render change to the customer if needed.

Through the two layout alternatives that are developed in this project, the inefficiencies that can be addressed by facilities planning, are done so. The practical limitation of not being able to move the kitchen area, also lessens the number of possible layout alternatives. The inefficiencies that are identified at the beginning of the project are analysed and it is noticed that some inefficiencies may be addressed through facilities layout analysis and improvement and others may be addressed through simply making general recommendations concerning staff members' responsibilities.

In the layout alternatives developed, it is felt that the inefficiencies that may possibly be addressed by facilities layout analysis and improvement, are indeed addressed by them.

Consequently, the remaining inefficiencies will be addressed by general recommendations and a business process diagram will show how the internal process will look when these recommendations have been implemented.

Step 5: Multi-Attribute Utility Theory (MAUT) and Selection of Best Layout
This step will be discussed at the end of this document.

4.3 Alternative Layout Simulations

4.3.1 Alternative Layout 1 Simulation

In Figure 4.8, the first alternative layout's simulation representation is displayed.

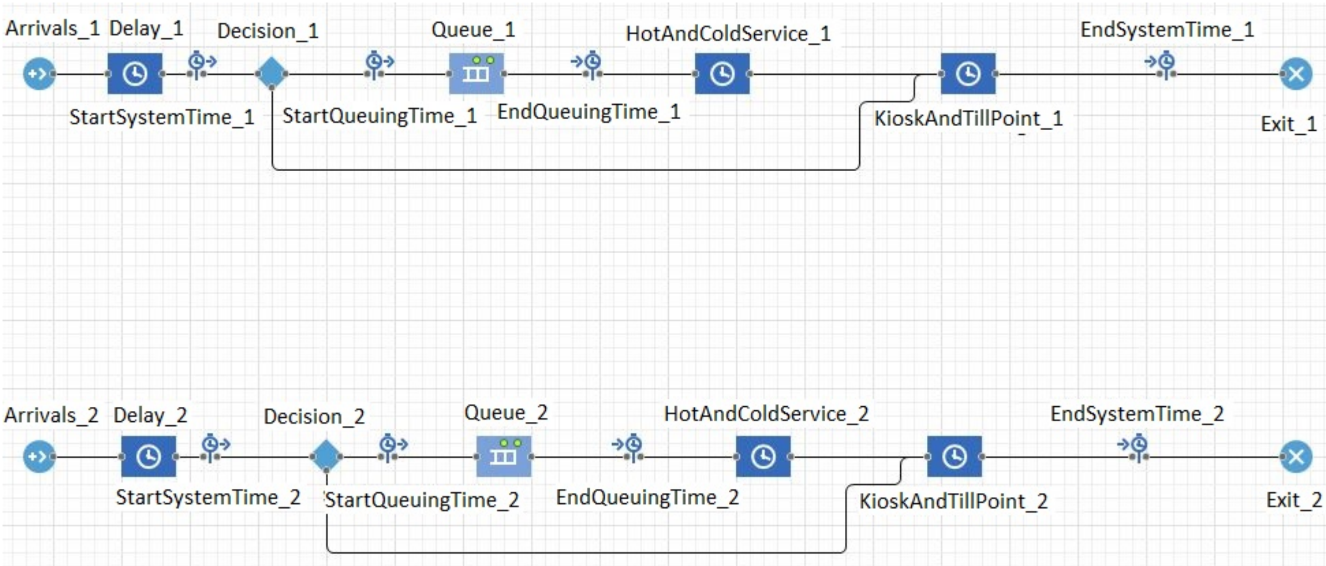

Figure 4.8: Alternative Layout 1 Simulation

When comparing the queuing times of the current layout with those of alternative layout 1, one can already notice an improvement. This is expected, as the service stations are doubled and thus, the load of workers are split between the two service stations.

The simulation is run 50 times, the mean queuing time for each iteration is then captured and analysed. Figure 4.9 shows the data captured from the simulation model and the fitted distribution.

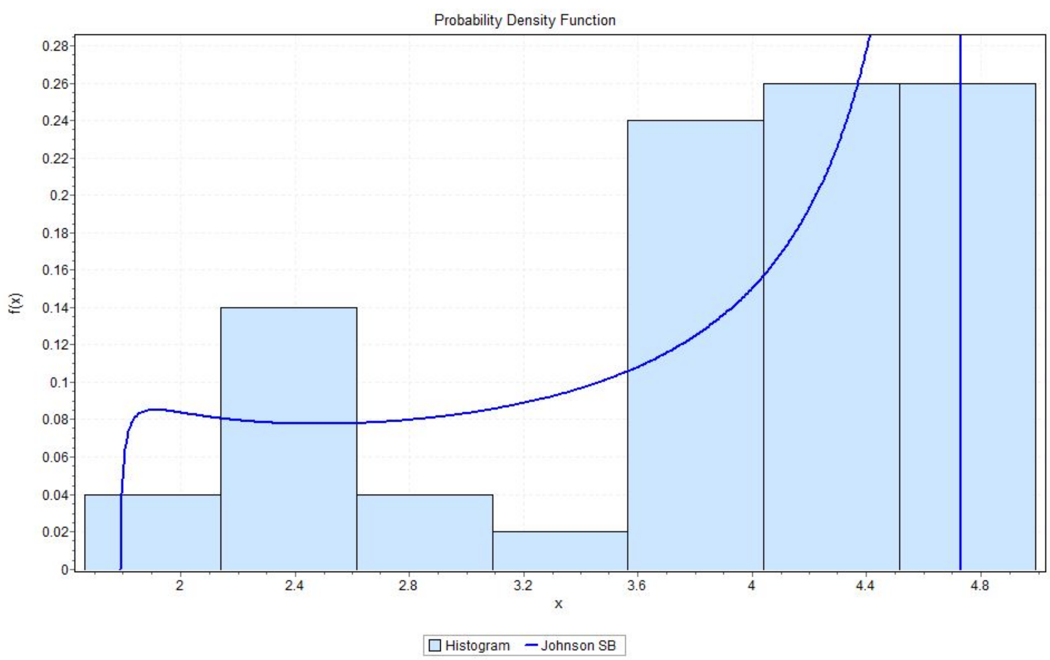

Figure 4.9: Alternative Layout 1 Simulation's Queuing Time and Fitted Distribution

The resulting queuing times of this alternative layout is found to be given by a Johnson SB (system bounded) distribution, with the following parameters; gamma (shape parameter) equal to -0.67431, delta (shape parameter) equal to 0.44279, lambda (scale parameter) equal to 2.9458 and zeta (scale parameter) equal to 1.7867. This means that the probability of the queuing time being greater than 3.5 minutes, is 70.14 per cent. Alternatively, the probability of the queuing time being greater than 8 minutes is zero per cent.

4.3.2 Alternative Layout 2 Simulation

Figure 4.10 displays alternative layout 2's simulation representation.

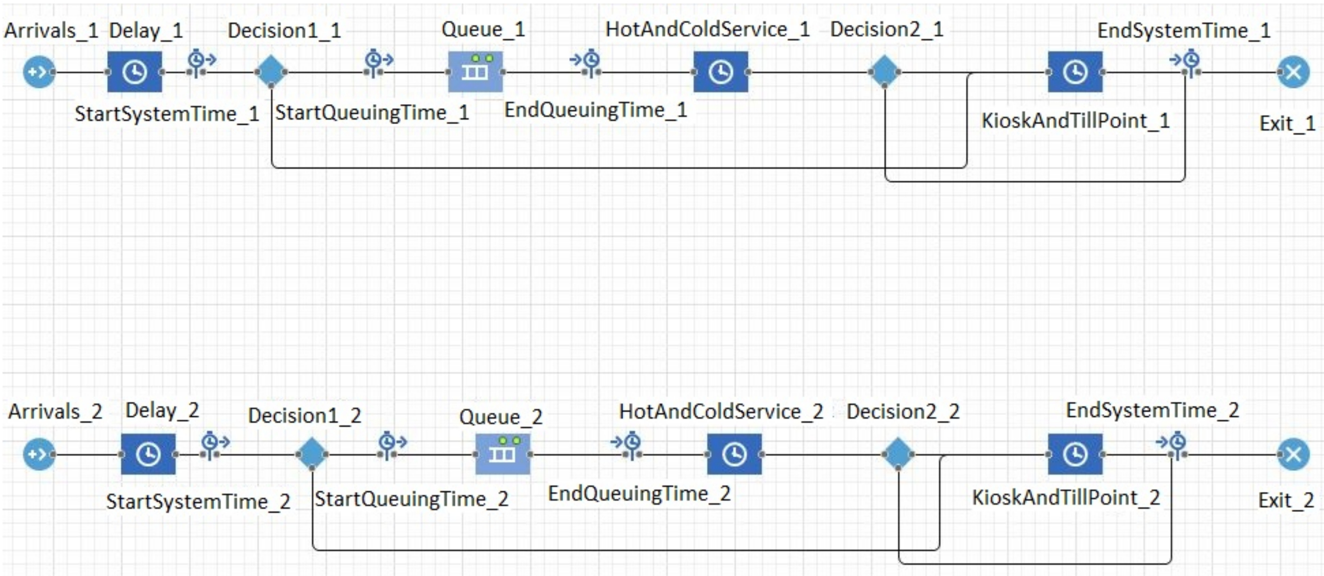

Figure 4.10: Alternative Layout 2 Simulation

The biggest difference between the two alternatives, in terms of the simulation model, is the fact that the workers that have to sign a list to pay and the workers that pay at the till point, are able to split.

The simulation is run 50 times, the mean queuing time for each iteration is then captured and analysed.

Figure 4.11 shows the data captured from the simulation model and the fitted distribution.

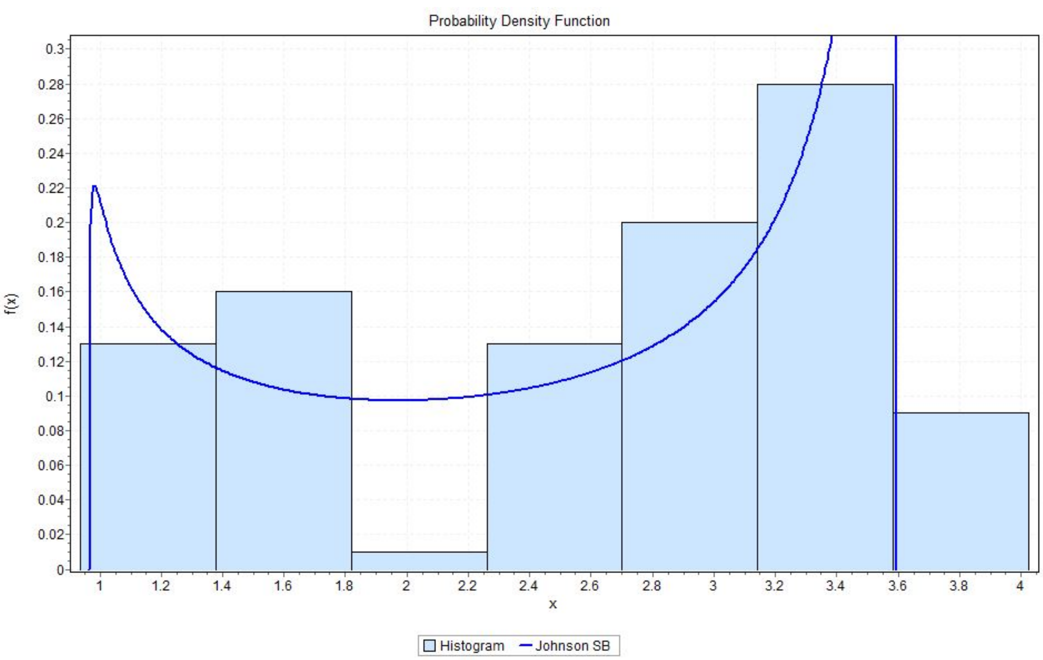

Figure 4.11: Alternative Layout 2 Simulation's Queuing Time and Fitted Distribution

The resulting queuing times of this alternative layout is found to be given by a Johnson SB (system bounded) distribution, with the following parameters; gamma (shape parameter) equal to -0.38544, delta (shape parameter) equal to 0.40605, lambda (scale parameter) equal to 2.62958 and zeta (scale parameter) equal to 0.96557. This means that the probability of the queuing time being greater than 3.5 minutes, is 17.17 per cent. Alternatively, the probability of the queuing time being greater than 8 minutes is zero per cent.

4.4 Concluding Remarks

In this chapter, the SLP process was executed up to the point where layout alternatives were developed. Alternative layout 1 was developed and depicted using the MS Visio software. Alternative layout 2's business process was selected as best suited, as responsibilities that were previously overlapping between the various staff members, are now allocated to specific staff members. This allows staff members to focus on their core responsibilities, as apposed to getting caught up in different responsibilities and causing inefficiencies in the system.

The process, associated with this alternative layout, was described and visually represented in a business process diagram. The same was done for alternative layout 2 and the inefficiencies that were addressed through this layout, were described. The two alternative layouts' simulation models were then developed and their results (queuing times) were analysed. For comparison purposes, Figure 3.6, 4.9 and 4.11 are also shown in Appendix C.

It was found that the probability of the queuing time being greater than 3.5 minutes, for the current layout, alternative layout 1 and alternative layout 2 are respectively 100 per cent, 70.14 per cent and 17.17 per cent. It was also found that the probability of the queuing time being greater than eight minutes, for the current layout, alternative layout 1 and alternative layout 2 are respectively 59.47 per cent, zero per cent and zero per cent.

From this comparison it can be concluded that alternative layout 2 produces the best results in terms of queuing times.

The last step of the SLP process, namely the application of the MAUT technique, and the selection of the best alternative layout will be addressed in the next chapter.

Chapter 5

Results and Recommendations

5.1 Multi-Attribute Utility Theory (MAUT) and Layout Selection

The Multi-Attribute Utility Theory (MAUT) (Flessas et al., 2015) technique is now used as a multi-criteria assessment, in order to select an alternative that will be best suitable for Company X's canteen.

There are three attributes identified as criteria for the alternative layouts: queuing time, the simplicity of the process associated to that layout and the cost resulting from that layout change.

The queuing time for each alternative will be a result of the respective layout's simulation. The queuing time is actually considered as the criteria of greatest importance, as this directly influences the efficiency of the canteen. This is also the criteria that will indicate if the alternative layout is able to make the process of visiting the canteen, more comfortable for the customers (workers). But because Company X is a business, and cost has the greatest influence in their budget and profitability, cost is allocated the largest weight.

The process simplicity of each layout will be evaluated based on the process mapping (business process diagrams) of each alternative.

The cost assessment for each layout alternative will be done in an abstract manner. For example, if five new staff members have to be employed in one alternative, but only two new staff members have to employed in the other, then the second alternative will be rated better in the cost criteria than the other.

Flessas et al. (2015) uses a 20-point continuous scale, zero being a much lower performance than shown by the current layout, and 20 as the maximum score, such that the expected performance is much higher than the current one.

For this project, the scale will be slightly adjusted. A 10-point continuous scale is used, zero being an equal performance to what is shown by the current layout. Five serves as the maximum score, such that the expected performance is much higher that the current one. When an alternative layout's performance is lower than that of the current one, in a certain criteria, the layout will receive a negative score. Negative five being the most negative score to be given. Thus, the scale used to rate the alternative layouts for this project, is slightly adjusted from that of Flessas et al. (2015).

The analysis focuses on one of the most critical periods, the lunch service, since 600 workers pass through the canteen in that time (one of their peak periods).

Table 5.1 shows how the MAUT technique is applied.

Criteria	Weight	Alternative 1	Alternative 2
Queuing Time	30	3	5
Process Simplicity	30	0	5
Cost	40	-5	-5
Total	100	-110	100

Table 5.1: Multi-Attribute Utility Theory Technique Applied

In the queuing time criteria, the layout alternatives are rated as above, resulting from the queuing times produced from their simulation models.

Alternative layout 1 is given a zero on the 10-point scale, in the process simplicity criteria, as there is no improvement in this regard from the current layout. Alternative layout 2 receives a five rating in this criteria, as responsibilities that were previously overlapping between the various staff members, are now allocated to specific staff members. This allows staff members to focus on their core responsibilities, as opposed to getting caught up in different responsibilities and causing inefficiencies in the system.

Both alternative layouts are given a negative 5 rating in the cost criteria, as five additional staff members will have to be employed, for both layouts to function as it should.

As concluded from Table 5.1, alternative layout 2 should be selected as the best suited layout for Company X's canteen.

5.2 General Recommendations

- The first problem that cannot be addressed by a facilities layout solution, is the issue of the two head cooks also serving at the hot- and cold services and having to return to the kitchen regularly, whether to check that everything is in order or to collect the food.

  Having one or two cooks holding the fort, while the two head cooks are serving the workers outside, seems to be problematic in this situation. The fact that, at the canteen's busiest times, only one staff member is left to serve the workers at the hot- and cold stations, definitely requires some attention.

  It would be recommended that the two head cooks are permanently appointed to the kitchen, while the other two cooks are available for assistance during the preparation before the workers arrive. The assisting cooks can then be the ones serving the workers at the service stations, instead of the head cooks. This way the cooks that are serving the workers don't need to return to the kitchen while serving, as the head cooks have everything under control.

  The head cooks can then just replace the hot storage box with the next tray of food when needed and the servers may then simply replace the empty food tray at the service station with the trays from the hot storage box.

- Also, I would recommend Company X appoint a staff member that has the responsibility of collecting the trays and plates from where the workers leave them (one the allocated trolleys) in order for the two staff members washing the dishes, to only be concerned with washing the dishes and not collecting them as well. Currently, the two staff members washing the dishes make turns to collect the used trays and dishes. This staff member will then also bring the clean plates and trays to the service stations as they become available.

- Through interviews and observation, I would strongly recommend that the canteen have at least 400 plates available per meal period. At the moment there are 200 plates available for all 600 workers, in a lunch period. As mentioned before, this causes regular interruptions at the hot- and cold service stations when there are no clean plates available for the workers.

- The issue of the second sales lady, assisting with the kiosk sales, but also making the salads and sandwiches must also be addressed.

  With the alternative layout there are two kiosk areas and two till points. This means, that if the canteen would like to keep two sales ladies at these two areas collectively, they will require four ladies in total. This will incur even more labour costs. With the load of the workers begin split in the alternative layout, and the workers again being split before the till point (between those signing and those paying with cash), it is felt that having two workers only collecting kiosk items for the workers will be redundant. Since the workers that sign to pay, are mostly not allowed something extra from the canteen, it would be recommended that there is only one staff member appointed per till point and one staff member at each table, where the workers need to sign.

  This way the company may consider appointing one additional staff member to make the salads and the sandwiches, and when she is done with her main responsibility, she may assist where help is needed.

- As mentioned in the current inefficiencies section, the hot service station holds approximately 50 portions of what is served on the day. I would recommend that the head cooks place 25 portions in each tray in order for the two service stations to operate simultaneously. Otherwise there will be only enough trays of food for the one hot service station to operate.

Figure 5.1 illustrates the business process diagram of the serving area, when general recommendations are implemented. Figure 5.1 thus depicts the final recommended business process that would be in operation in the serving area.

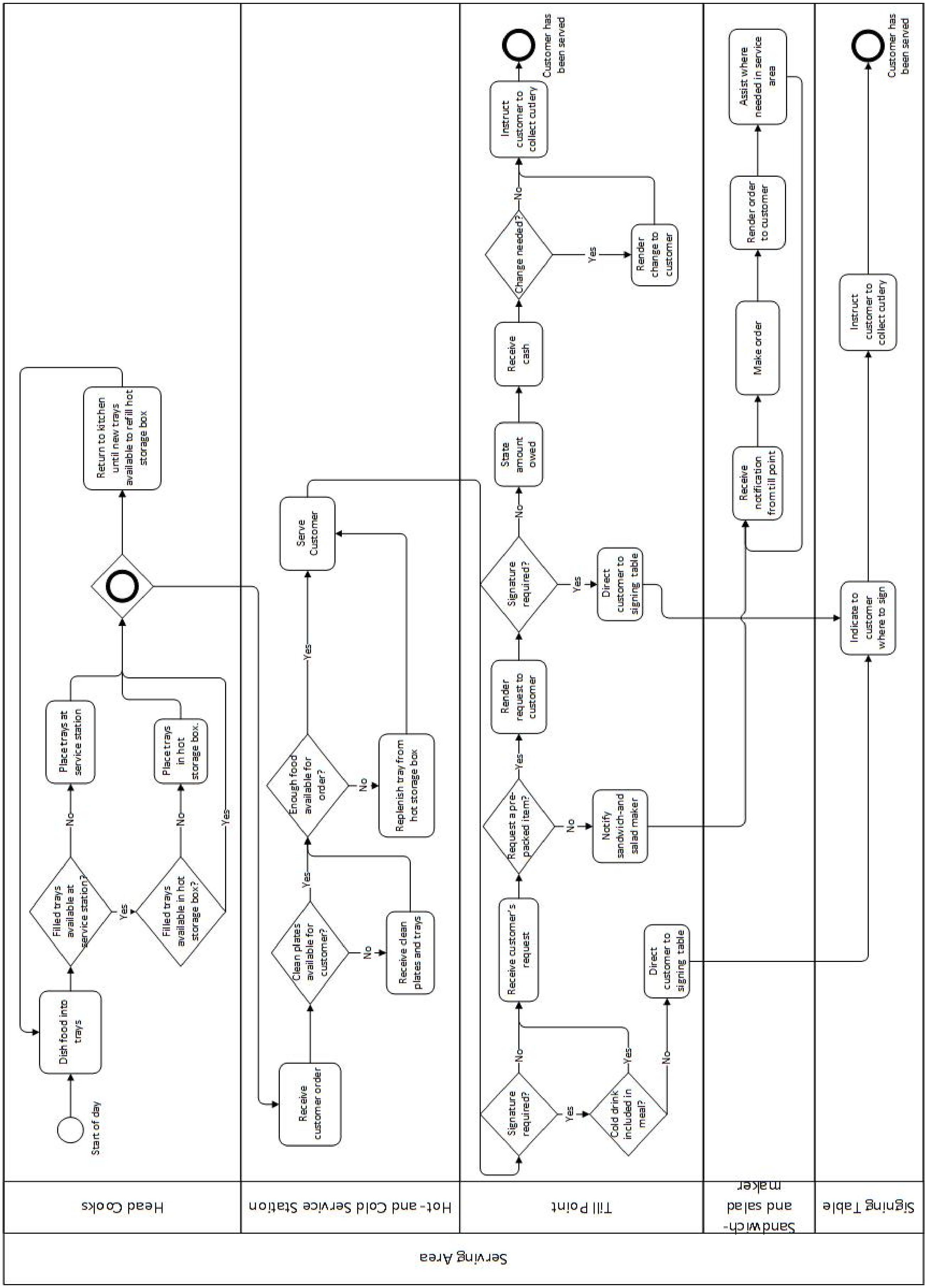

Figure 5.1: Business Process Diagram - Final Recommended Serving Area

At the start of the day the head cooks dish the food into the trays that are firstly placed at the service station and, when the service station is filled, the remaining trays are placed in the hot storage box. When the service station and the hot storage box are filled, the head cooks return to the kitchen, until there are new trays available to re-fill the hot storage box (after the trays have been replenished by the servers).

When the customers arrive, the first server (at the hot- and cold service station) has to observe whether or not there are clean plates. If there are, the server may receive the customer's order, if not, the server is expected to receive clean plates (and trays) from the plate- and tray collector shortly.

The server must then observe whether or not the available food is sufficient for the customer's order. If so, the server may serve the customer. If not, the server may replenish the tray from the hot storage box and serve the customer.

After the servers have served the customer, the customer moves to the till point. If the customer needs only to sign for his/her meal, the sales lady needs to discern whether or not the the customer's meal includes a cold drink. If not, the customer is directed toward the signing table. At the signing table there will be a staff member that indicates to the customer where to sign and ultimately instructs the customer to collect his/her cutlery.

If it is included, the sales lady may take the customer's request and render the cold drink to the customer. The sales lady will then discern whether the customer needs to sign for their food and drink, or not. If so, the customer is directed toward the signing table. At the signing table there will be a staff member that indicates to the customer where to sign and ultimately instructs the customer to collect his/her cutlery.

If the customer pays with cash for the meal, and has a kiosk request, the sales lady must now discern if the request is a pre-packed item or if it is a sandwich, that still has to be prepared. A pre-packed item may immediately be rendered to the customer, while the sandwich- and salad maker has to be notified when the request includes a sandwich.

In this case, the sandwich- and salad maker will receive the notification, make the order and render the order to the customer at the till point (where the till point's sales lady will further assist the customer). When the sandwich- and salad maker has completed her orders, she will assist where needed in the service station, until she receives the next order.

The lady may now state the amount due, receive the cash and render change to the customer if needed. The sales lady finally instructs the customer to collect his/her cutlery.

Figure 5.2 illustrates the business process diagram of the washing area, when general recommendations are implemented. Figure 5.2 thus depicts the final recommended business process that would be in operation in the washing area.

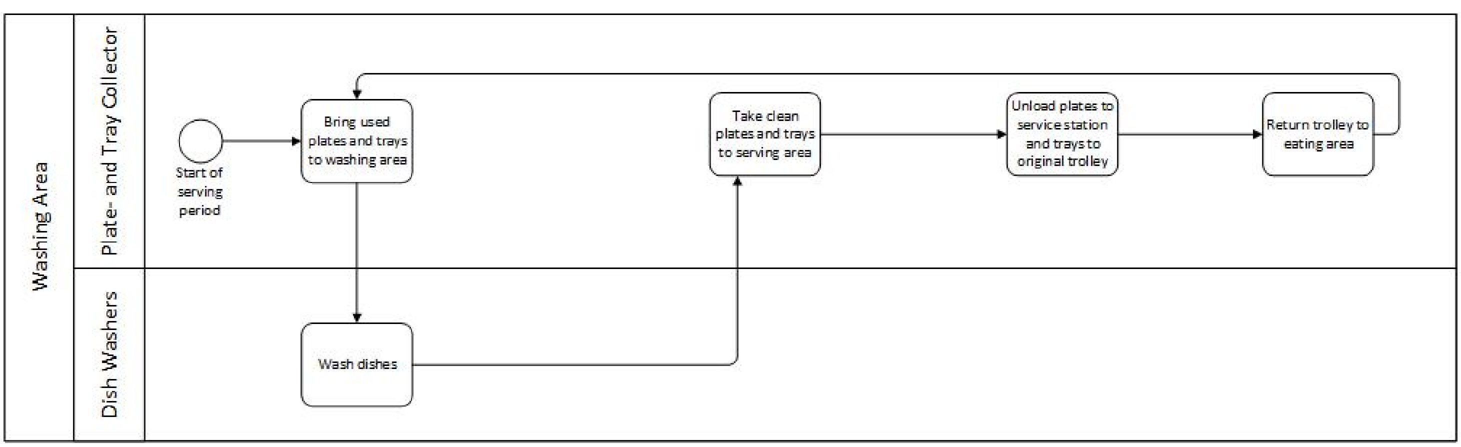

Figure 5.2: Business Process Diagram - Final Recommended Washing Area

At the start of the serving period, the plate- and tray collector will take the used plates and trays to the washing area. Here the dish washers (staff) will wash the dishes, whereafter the plate- and tray collector will take the clean plates and trays to the serving station.

He/she unloads the plates to the service station and the trays to the original tray stand. The trolley is then returned to the eating area, until the used plates and trays can again be brought to the washing area.

5.3 Concluding Remarks

In this chapter the MAUT technique was applied and it was concluded from Table 5.1, that alternative layout 2 is the best suited layout for Company X's canteen, in terms of the chosen criteria.

General recommendations were also given in order to address the inefficiencies that were not addressed through the layout improvements. Thereafter, a business process diagram was drawn up to depict the internal processes of the service- and washing area, after the recommendations are implemented.

Chapter 6

Conclusion

As a major retailer in Africa, Company X strives to address socio-economic challenges through the supply of high-quality, affordable food for all customers, while providing significant employment and economic opportunities across its value chain (Anon, nd). One of the basic principles that contribute to their growth and success, is maximising business efficiency. Ensuring the wellness of their workers at their distribution center, is pivotal to this principle. Thus, the canteen, where Company X's workers receive their meals daily, should be an area of great importance.

Company X's canteen experiences a heavy flow of traffic at specific times of the day, such as breakfast-, lunch- and dinner times. The two peak times are the lunch- and dinner times, at which times there are about 600 workers passing through the canteen. Queuing times for workers are extremely long and cause dissatisfaction, in these meal periods. This project will focus on the lunch time period.

As stated in the research objectives subsection, this project aims to create a more efficient canteen environment for Company X.

The research question for this project is thus formulated as: How can Company X's canteen efficiency improve through business process improvement and facilities layout planning?

The project aimed to answer this question, by firstly focusing on developing a more efficient facility layout for the canteen, and secondly considering the canteen staff's processes (business processes).

Before developing the alternative facility layouts, the current layout was analysed to identify where bottlenecks are present and what elements increase the inefficiencies of the canteen. After developing the alternative layouts using Systematic Layout Planning (SLP), their associated business processes were depicted using business process diagrams. The layouts were then assessed according to the chosen criteria, in order to determine if the efficiency of the canteen has been improved. The Multi-Attribute Utility Theory (MAUT) technique was used to select the most efficient layout (according to the chosen criteria) as the recommended layout for the canteen. Alternative layout 2 was selected as the recommended layout. This layout proved to be the most suitable layout for Company X based on the three criteria used in the MAUT assessment. The three criteria are cost, queuing time and process simplicity.

The main aim of this project, namely to create a more efficient canteen environment for Company X, was thus achieved through business process improvement and facilities layout planning.

General recommendations were also made in order to address the inefficiencies that the layout improvements were not able to address. Business process diagrams were then also drawn up in order to depict the internal processes of the serving- and washing area, when recommendations have been implemented. These business diagrams may be seen as the final recommended business processes for Company X's canteen.

Future possible improvements for this project may include making the simulation model more accurate in order to generate more accurate queuing time outputs. This may be done by spending more time doing time studies, as more data collected will mean increased accuracy of the delay times at each service station. Specifying, in the simulation model, what arrival rate should be operating at what time of the meal period, could also make the model more realistic.

More criteria may also be identified, against which the management may want to assess the newly developed layouts.

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Appendix A

Signed Industry Sponsorship Form

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Department of Industrial & Systems Engineering
Final Year Projects
Identification and Responsibility of Project Sponsors

Final Year Projects may be published by the University of Pretoria on *UPSpace* and may thus be freely available on the Internet. These publications portray the quality of education at the University, but they have the potential of exposing sensitive company information. It is important that both students and company representatives or sponsors are aware of such implications.

Key responsibilities of Project Sponsors:

A project sponsor is the key contact person within the company. This person should thus be able to provide guidance to the student throughout the project. The sponsor is also very likely to gain from the success of the project. The project sponsor has the following important responsibilities:

1. Confirm his/her role as project sponsor, duly authorised by the company. Multiple sponsors can be appointed, but this is not advised. The duly completed form will considered as acceptance of sponsor role.
2. Review and approve the Project Proposal, ensuring that it clearly defines the problem to be investigated by the student and that the project aim, scope, deliverables and approach is acceptable from the company's perspective.
3. Review the Final Project Report (delivered during the second semester), ensuring that information is accurate and that the solution addresses the problems and/or design requirements of the defined project.
4. Acknowledges the intended publication of the Project Report on UP Space.
5. Ensures that any sensitive, confidential information or intellectual property of the company is not disclosed in the Final Project Report.

Project Sponsor Details:

Company:	Pick 'n Pay
Project Description:	Improving canteen efficiency through business process improvement and facilities layout planning
Student Name:	Suané Cillie
Student number:	12106845
Student Signature:	SCillie
Sponsor Name:	TRUDIE - ELIZE DU TOIT
Designation:	CI LOGISTICS ANALYST
E-mail:	TRUDIEDUTOIT@PNP.CO.ZA
Tel No:	011 574 4664
Cell No:	076 903 0331
Fax No:	—
Sponsor Signature:	Dutoit

Appendix B

Data Analysis of Data Captured

B.1 Arrival Rate

Figure B.1 shows the arrival rate data captured and the fitted distribution.

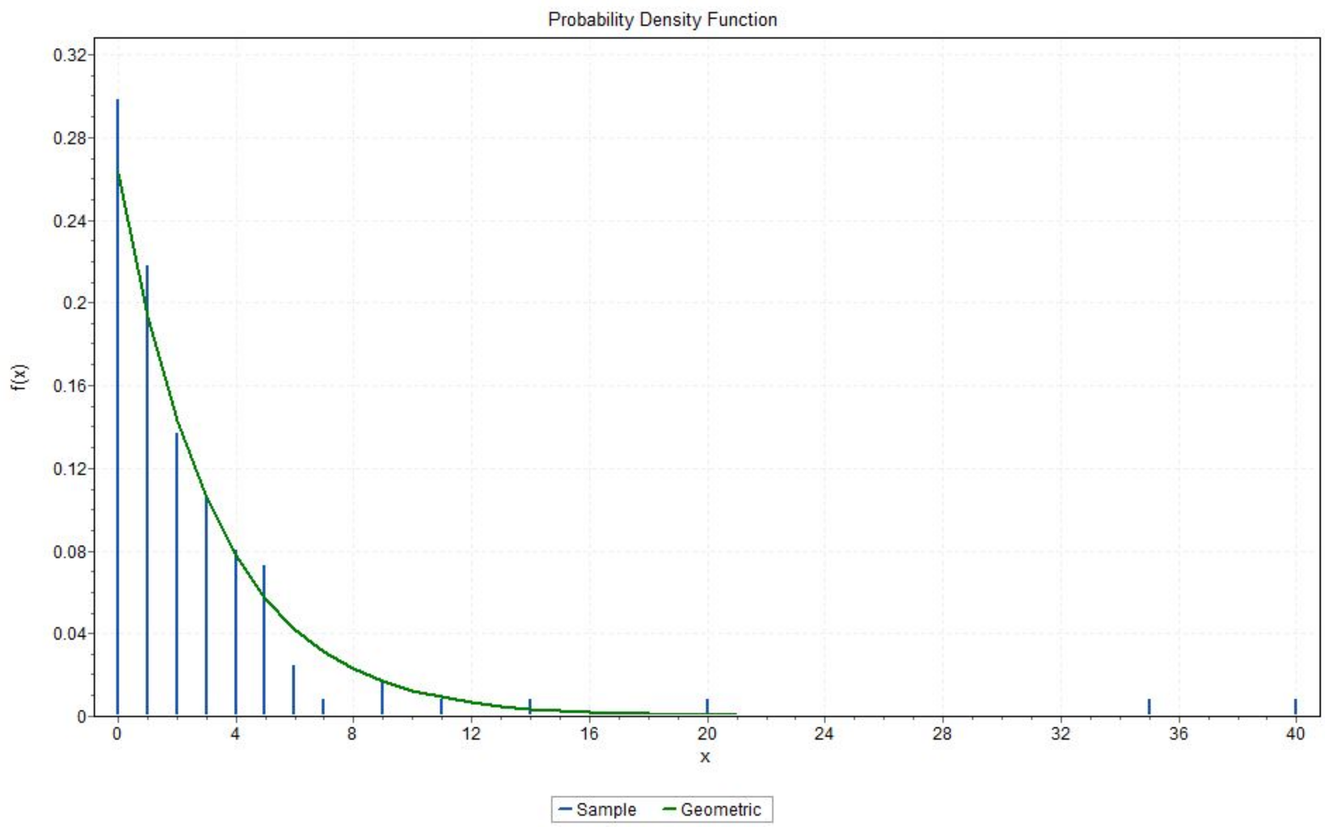

Figure B.1: Arrival Rate Data Captured and Fitted Distribution

Associated parameter given: continuous success probability (p) equal to 0.26271.

B.2 Hot- and Cold Service Stations

Figure B.2 shows the hot- and cold service time data captured and the fitted distribution.

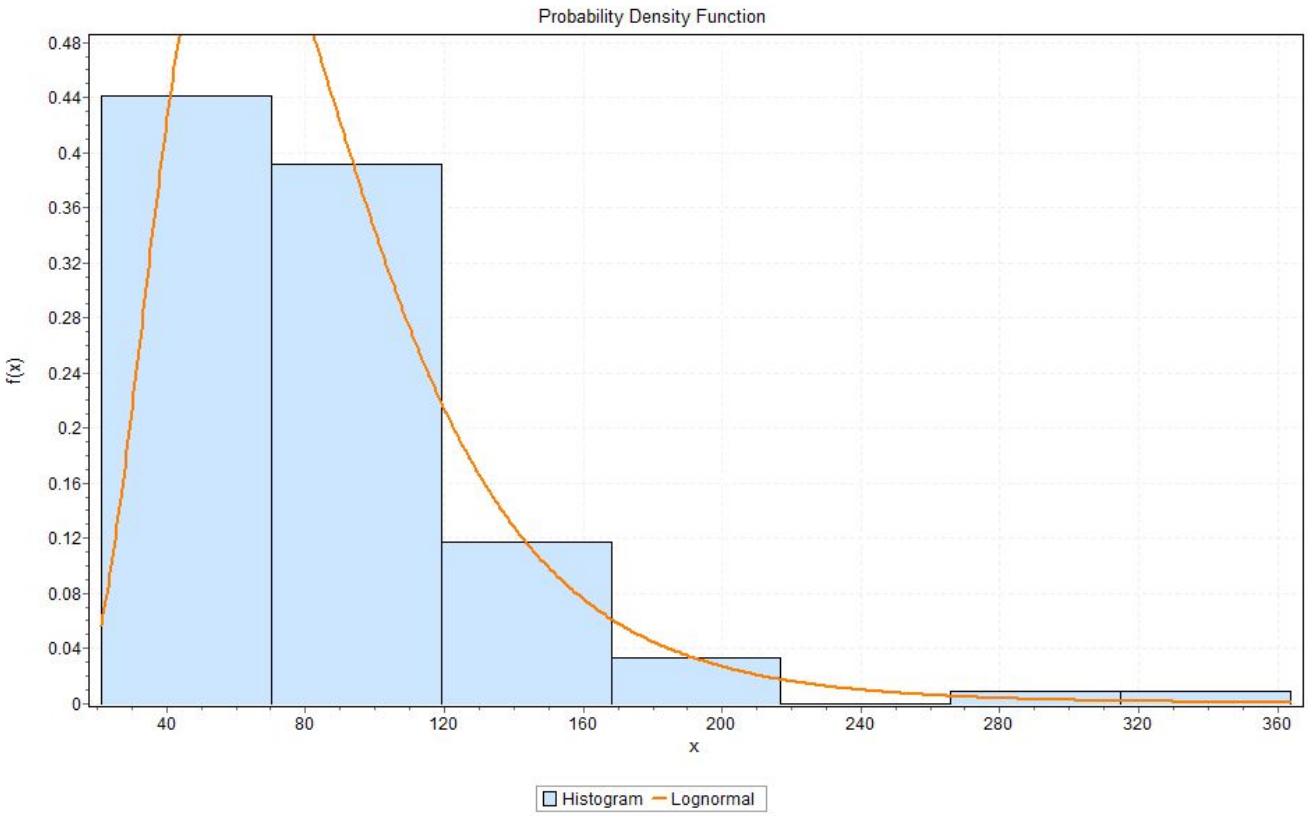

Figure B.2: Hot- and Cold Service Station Data Captured and Fitted Distribution

Associated parameters given: the mean of the included normal (mu) equal to 4.3266, standard deviation of the included normal (sigma) equal to 0.482 and the minimum value being equal to 1.322.

B.3 Kiosk and Till Point

Figure B.3 shows the kiosk and till point service time data captured and the fitted distribution.

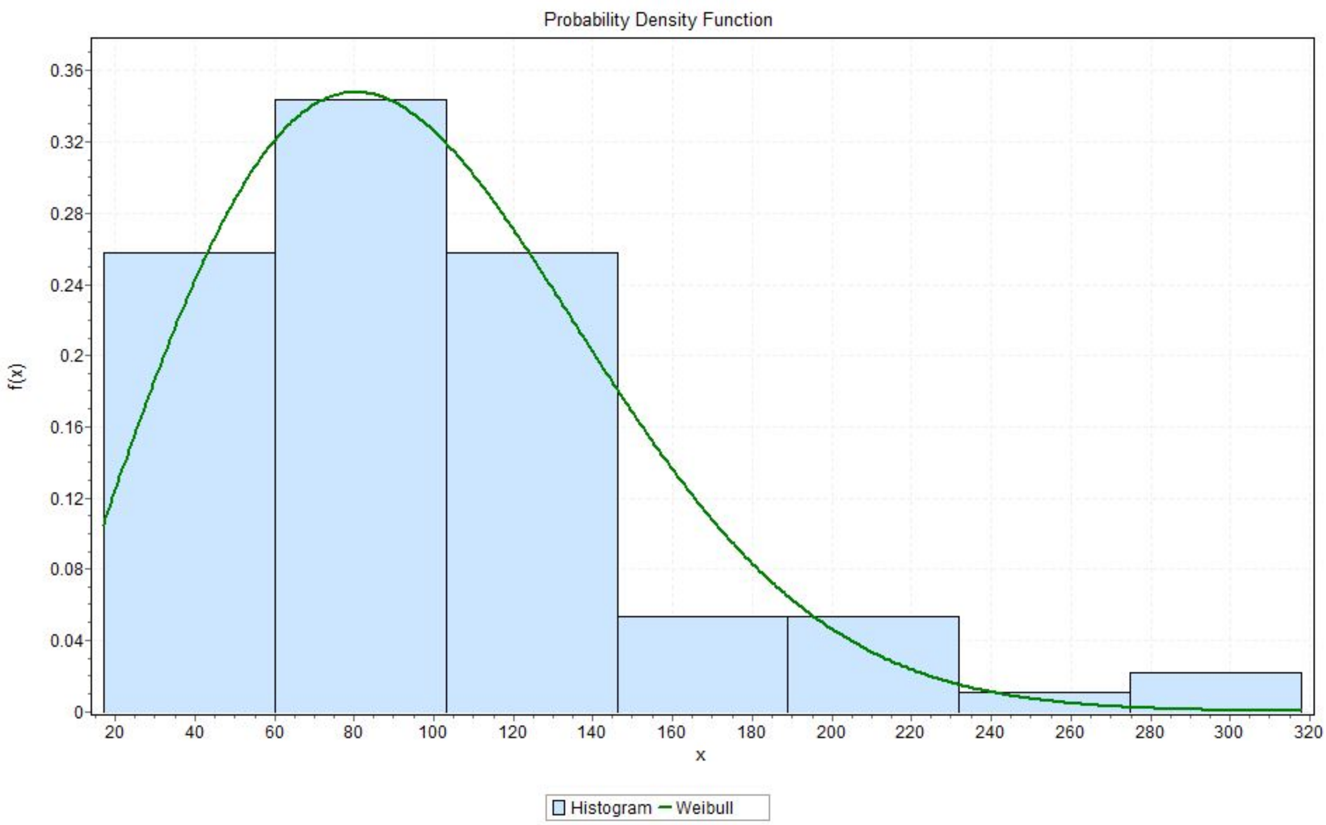

Figure B.3: Kiosk and Till Point Data Captured and Fitted Distribution

Associated parameters given: shape parameter (alpha) equal to 2.0969, scale parameter (beta) equal to 109.41 and the minimum x value being equal to 17.

Appendix C

Data Analysis of Alternative Layouts' Results

C.1 Current Simulation

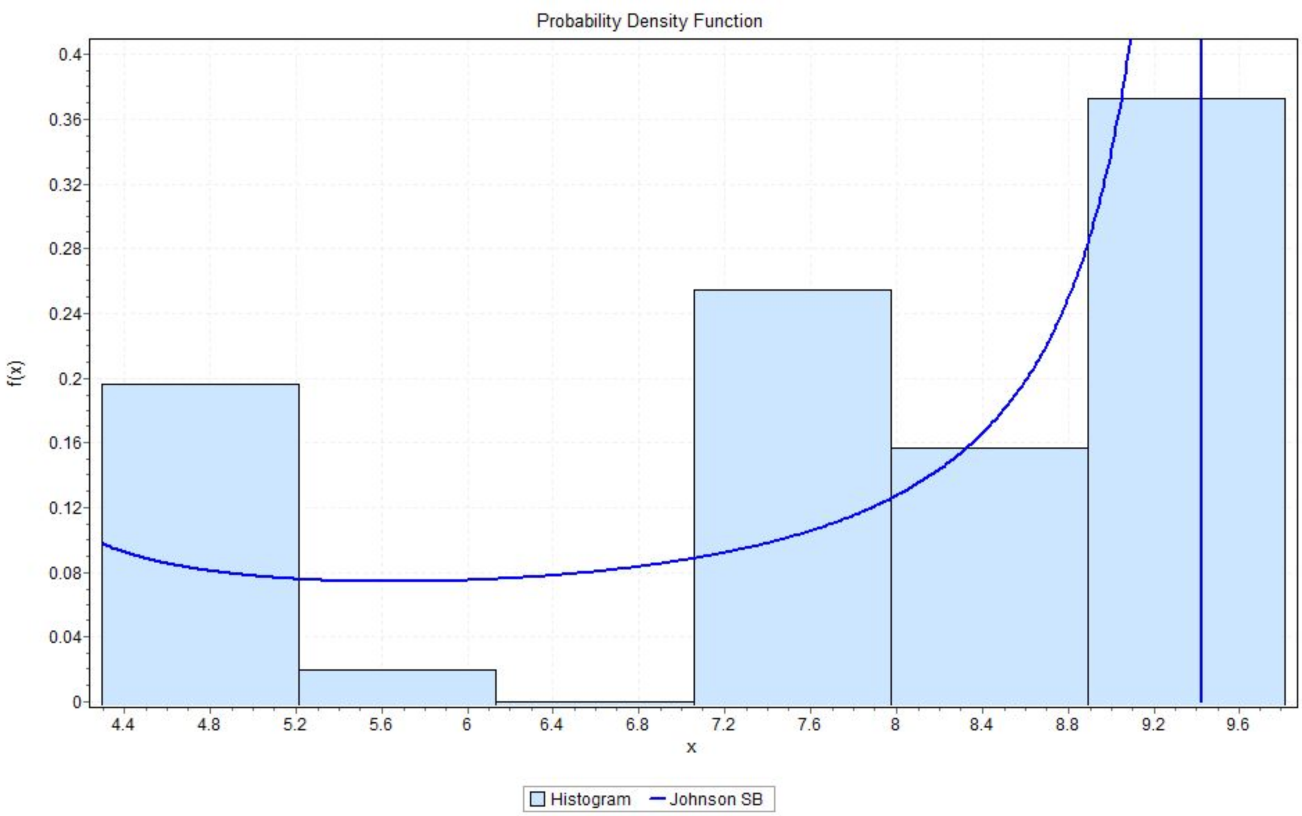

Figure C.1: Current Simulation's Queuing Time and Fitted Distribution

C.2 Alternative Layout 1 Simulation

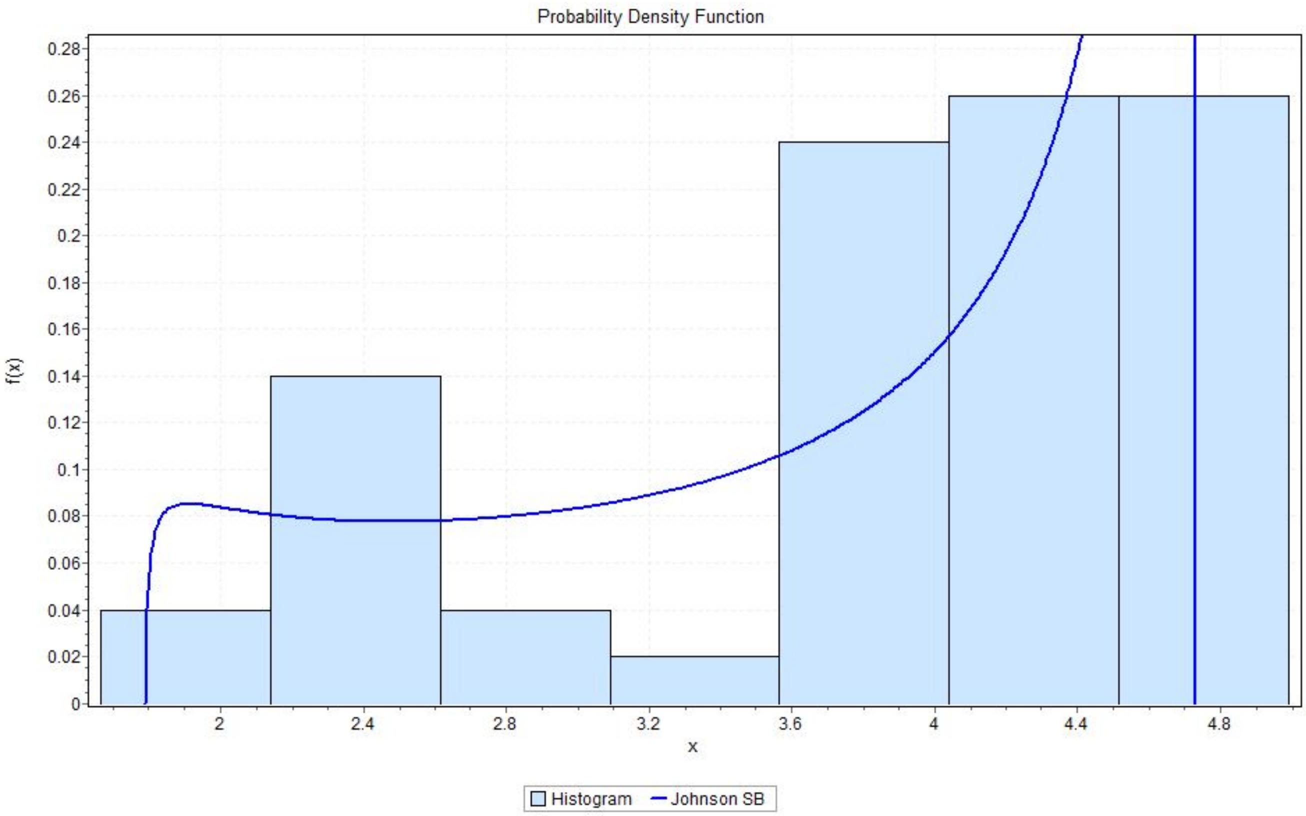

Figure C.2: Alternative Layout 1 Simulation's Queuing Time and Fitted Distribution

C.3 Alternative Layout 2 Simulation

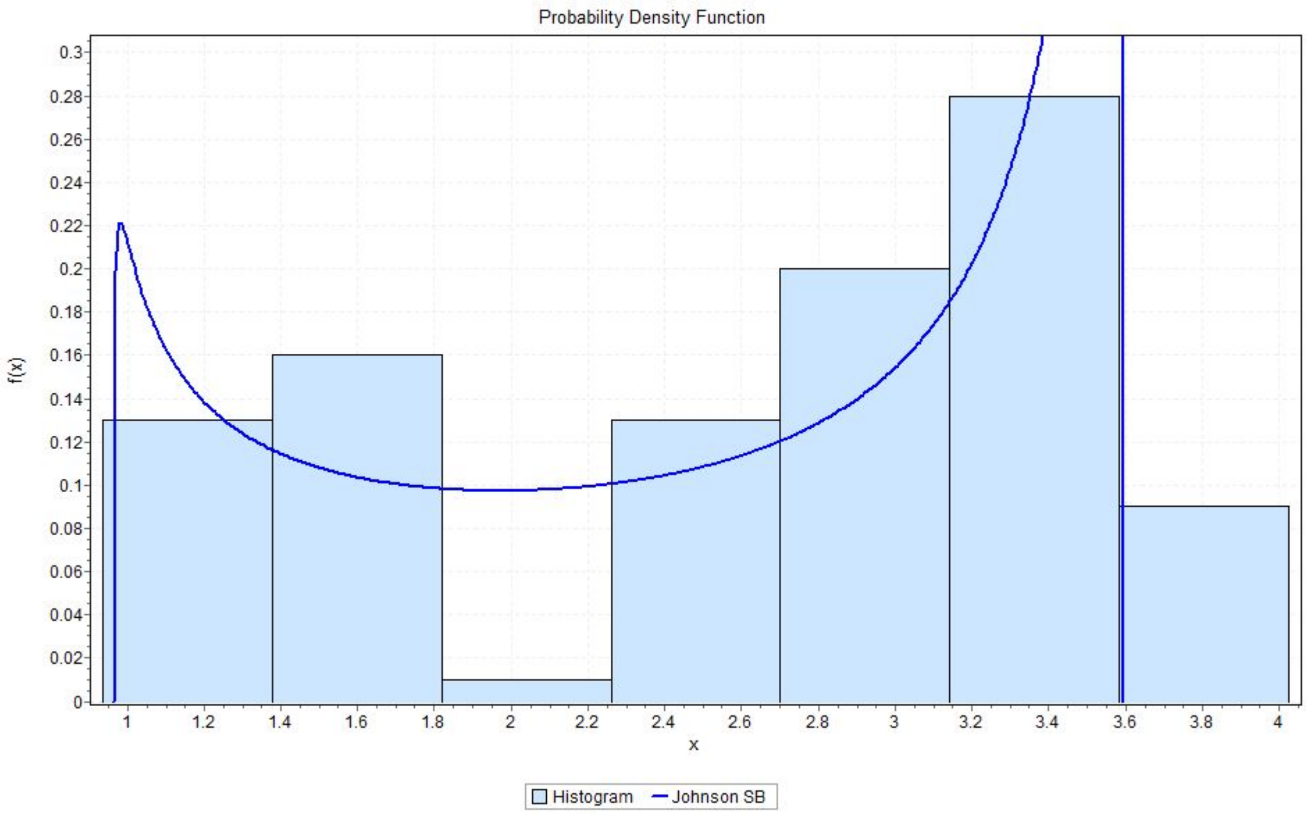

Figure C.3: Alternative Layout 2 Simulation's Queuing Time and Fitted Distribution