UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Perceptions on the fourth industrial revolution and agricultural economics-the case of University of Pretoria alumni.

By

Sikhanyiso Mhaka

Dissertation submitted in partial fulfilment of the requirements for the degree MSc (Agric) Agricultural Economics

Department of Agricultural Economics, Extension and Rural Development

Faculty of Natural and Agricultural Sciences

University of Pretoria

Pretoria

November 2019

DECLARATION

I, Sikhanyiso Mhaka, declare that the dissertation, which I hereby submit for the degree MSc(Agric) Agricultural Economics at the University of Pretoria, is my own work and has not been submitted for a degree at any other tertiary institution.

Signature: ……..……

Date: ……..

DEDICATION

This study is dedicated to my tenacious parents Mr Cain George and Mrs Catherine Mhaka who passed down this trait to me. I have witnessed how you tenaciously hold on to dreams, pursue them against all odds and accomplish them and this apple did not fall too far from the tree. Thank you for encouraging me to soldier on, aim higher as I remain focused.

ACKNOWLEDGEMENT

Firstly I would like to thank my Lord God and Saviour. Dear Lord, I just want to thank you for bringing me this far. This was not an easy journey at all, but you carried me through it all. Accomplishing this degree is a testament that when you called me to walk upon the waters, in the great unknown where feet may fail it is because you had confidence in me and you were never going to forsake me. I have cried, I have been broke and broken, and felt like giving up on countless occasions, but you remained faithful. Thank you, Lord.

I would like to extend a word of gratitude and appreciation to the following individuals who supported me throughout my studies.

- To my supervisors, Dr Marlene Louw and Dr Melissa van der Merwe, thank you not only for academic support, supervision and guidance but for always encouraging me. Thank you for every opportunity to learn and refine my work.
- To my parents, when I decided to take a leap of faith out of comfort zone, you believed in my dreams, you prayed and still pray for me. I am so grateful to be your daughter. Sikhulile, Tovimbanashe, Shumba and Jena thank for praying for me and your insurmountable support. Keyla and Nigel, thank you for always being my cheerleaders.
- To my colleagues, Rose, Yvonne, Christa, Charlotte and the entire department of agricultural economics, thank you for having my back and helping me to stabilise my finances.
- To my friends, Mufaro, Karen, Tracy, Wendy, Chris, Eustensia, Ikageng, Dr Elizabeth, Kholofelo, Dr Nokhuthula, tete Memo, thank you guys for always providing a shoulder to cry on. Malven Tunhuma, for all the proof reading, constructive criticism and motivation, I am really grateful.
- To my sisters and team, Vivian, Kudzanai, Petronilla, Uncle Ray and Tanaka, you guys can attest how difficult this was, and yet you stood by me. May God bless you so much.
- Elim church and ladies cell, AFM church and cleaning ministry, Dr Charity Nhemachena and Dr Colleta, the Chidongos thank you for being the family that I never had. I am grateful for every prayer and best wishes.

ABSTRACT

Perceptions on the fourth industrial revolution and agricultural economics-the case of the University of Pretoria alumni.

By

Sikhanyiso Mhaka

Degree: MSc (Agric)
Department: Agricultural Economics, Extension and Rural Development
Supervisor: Dr Marlene Louw
Co-supervisor: Dr Melissa van der Merwe

Tertiary education is servicing a rapidly changing labour market which is driven by the digital revolution. Big data is prefigured as the raw material of the digital revolution and its resulting concepts such as automation and artificial intelligence, blockchain technology and robotics which are reshaping the nature of the workforce in every sector of the economy. The digital revolution concepts are increasingly assumed that it will augment human abilities by assisting human beings to reduce tedious and monotonous tasks, thereby allowing human beings to spend more time on creative endeavours. On the other hand, the same innovations will result in job losses. This set of circumstances warrants a tracer study into assessing if the programme supply is speaking to market demand so as to advise curriculum review. The impact that big data, automation and artificial intelligence, blockchain technology and robotics have on the agricultural economics profession is not yet known and more so how much of it are the graduates exposed to in their current jobs. This study, therefore, provided some insight into the impacts of some of the digital revolution concepts by capturing the perceptions of the University of Pretoria alumni. Out of a total of 165 graduates, from an undergraduate programme in Agricultural Economics at the University of Pretoria, 50 respondents completed the on-line questionnaire.

The results obtained indicated that a large proportion of the graduates, 82%, are gainfully employed with the majority employed in the agriculture and food sector. The graduates are proficient with most of the skills expected of agricultural economists but that they needed improvements in computer programming skills, advanced IT and analytical skills which are

rendered as very essential skills for the digital revolution labour market. To determine the familiarity of the graduates with general concepts related to the digital revolution, their familiarity score was calculated. The scores ranged from 13 to 23, and the average score was 17.5 which was more skewed towards the low familiarity. Using familiarity as a proxy for the adoption of new technologies, the results suggested that the graduates are not adept at using new digital technologies hence negatively affecting their adoption. To identify the key determinants of propensity to adopt to new digital technologies, years of experience and undergraduate academic performance were considered. Neither academic performance nor years of professional experience were statistically significant in explaining the propensity to adopt new technologies. Having established that none of the variables of interest was statistically significant and could be used to determine the graduates' aptitude to adopt new technologies, the graduates' perceived impacts were considered. The graduates perceive an increased prevalence of automation, big data, artificial intelligence, robotics and blockchain technologies in their current jobs as years ensue. The popular impact perceived as a result of the application of robotics and artificial intelligence is employment loss. Big data and automation are commonly perceived to result in making work easier. Application of blockchain technology is perceived as having no impact on the nature of jobs by most of the graduates.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

Abbreviation	Explanation
ACET	Advisory Council on Education and Training
AI	Artificial Intelligence
ATM	Automated Teller Machine
CROO	Computerised Robotic Optimized Obtainer
GPA	Grade Point Average
GPS	Global Positioning System
ICT	Information and Communication Technologies
IoT	Internet of Things
IT	Information Technology
SABC	South African Broadcasting Corporation
SAFEX	South African Futures Exchange
SIRI	Speech Interpretation and Recognition Interface
UNESCO	United Nations Educational, Scientific and Cultural Organizations
US	United States

CHAPTER ONE

INTRODUCTION

1.1 Background

The global economy is paying wages worth US$ 16 billion for about 50% of activities that could be automated owing to digital technology advancements (Manyika *et al*., 2017). Automation is expected to impact all sectors of the economy (Xu *et al*., 2018), with 60% of all jobs having at least 30% potential of their activities being automated (Manyika *et al.,* 2017) and thereby reducing the demand for human labour in the labour market (Brown *et al.,* 2017). Butler-Adam (2018) asserts that it no longer makes sense to ask children what they would like to do when they grow up as most of the conventional jobs would have disappeared by the time they enter the labour market. At the same time, some currently undefined occupations will, in the future, become daily and relevant jobs (Butler-Adam, 2018). According to Banwari (2018), the most sought after skills currently did not even exist in the period 5 to 10 years ago. This is causing shifts in the skills demanded on the labour market (Brown *et al.,* 2017). Higher education institutions as suppliers of employees to the labour market (Mocanu *et al.,* 2014, Escotet, 2012; Fortino, 2012), are accountable to a host of stakeholders such that there is a great need to equip graduates with skills that can meet the demands of the labour market as well as prepare them for the hastily changing labour market (Marwala, 2017). Moreover, the global labour market has not been performing well, and there are on-going debates on whether the growing global unemployment rate is a result of technological unemployment (Frey and Osborne, 2017) or the calibre of graduates produced for the labour market (McCowan *et al.,* 2014). Like all the other disciplines, agricultural economics need to investigate and prepare for the changes that are confronting the labour market. Besides, universities need to critically evaluate and make the necessary changes to their curricula so that it becomes better aligned with the demands of the new labour market. All the changes in the labour market and the environment tertiary education is operating in are happening in the advent of the fourth industrial revolution, and it is occurring at an exponential rather than a linear rate (Xu *et al.,* 2018; Stone *et al.,* 2016).

1.2 Industrial Revolutions, Labour markets and Education

1.2.1 Industrial Revolutions over time

The fourth industrial revolution is preceded by three other industrial revolutions. Table 1.1 below summarises the main characteristics of the industrial revolutions.

Table 1.1: Main characteristics of the industrial revolutions

Period	Energy source	Main Goal	Main Achievements	Relevant skills on the labour market
1760-1900	Water and Steam power	Mechanise production	Steam Engine	Practical trade crafts
1900-1960	Electric and oil power	Mass production	Creating steel, railways, Roads, Telegraph	Technical skills
1960-2000	Electronic and Information technology	Automate production	Computers, Robots	Less laborious work, more logical thinking and creative design
2000- to date	Green energy	Machines that teach themselves	Internet, 3D printers, Genetic Engineering	Creativity

Source**:** Caetano and Charamba, 2017; Schwab, 2015; Prisecaru, 2016)

The first industrial revolution which began in the period between 1760 and 1900 made use of steam and water power to mechanise production. The revolution mainly benefitted the textile industry as it resulted in shifting from using manual methods in manufacturing to the use of machines. The most sought after skills were those that were in line with practical trade crafts. The second industrial revolution began circa 1900 to 1960s and factories got into mass production induced by electric and oil power. The second revolution brought about infrastructure development such as the building of roads and railways, resulting in relatively high demand for technical skills on the labour market. It gave rise to consumer culture as more jobs were generated, more people started having more disposable income. The third industrial revolution, also known as the digital revolution, began in the 1960s to 2000. Production was automated using electronics and information technology. In the digital revolution, work became less labour intensive as machines

could learn using human interventions, thus making logical thinking and creative designs the most relevant skills. The third industrial revolution, with innovations such as the internet, provided the building blocks for the fourth industrial revolution (Schwab, 2016; Caetano and Charamba, 2017; Prisecaru, 2016). There are unclear lines between the third and the fourth industrial revolution as some still argue that we are still in the third industrial revolution (Caetano and Charamba, 2017) but whether we are in the third or fourth industrial revolution, the revolution is founded on green energy and the internet (Prisecaru, 2016). Although there are blurred lines between the third and fourth industrial revolution, machines in the fourth industrial revolution are smarter for they can teach and learn without human interventions thus making creativity the most relevant skills (Brown *et al.*, 2017).

1.2.2 The fourth Industrial Revolution and the labour market

Artificial intelligence, robotics, and automation are some elements of the fourth industrial revolution, which are reshaping the nature of work in every sector of the economy (Brown *et al.*, 2017). The raw material for these developments is big data (Huberty, 2015). The benefits of adopting the fourth industrial elements are described as profound (Stone *et al*., 2016). They will, among other things, augment human abilities as machines will assist human beings in reducing tedious and monotonous tasks, thereby allowing more time on creative endeavours (Brown *et al.*, 2017).

On the other hand, the same innovations are predicted to result in disruptions in the labour market and economy (Stone *et al.,* 2016). The anticipated disruptions include job losses (Brown *et al.*, 2017) also referred to as technological unemployment, and a reduction in labour costs (Peters, 2017). Some workers may be displaced while some may be rendered ill-suited for new opportunities created by digital technology advancements (Rotman, 2013). A study conducted by Frey and Osborne (2013) revealed that 47% of 702 specific jobs in the United States are highly susceptible to computerisation. Some of the occupations that have at least 0.97 probability of being automated are telemarketers, data entry clerks, credit analysts, drivers, pesticide handlers, procurement clerks and agricultural and food science technicians (Frey and Osborne, 2013).

In other industries, it has been reported that digital technology has already started eliminating routine jobs which require little education, leaving most employment opportunities to those with

higher education qualifications (Ford, 2013). Consequently, it could exacerbate the current global unemployment status (Kim *et al.*, 2014) as well as South Africa's unemployment status. According to StatSA (2019), in South Africa, 56% of the unemployed did not complete high school, 34.5% completed high school, and 2.1% are university graduates while 6.9% have other higher education qualifications. The relatively low proportion of unemployed graduates, (2.1%), in South Africa supports the notion that obtaining a degree can potentially increase access to the labour market. Furthermore, the jobs of people who have at least a degree are less susceptible to computerisation. The study by Frey and Osborne (2013) provided evidence by revealing that there is a strong negative relationship between education attainment and the probability of occupation to be computerised. Despite this, we need to make sure that the degree outcomes align with labour market requirements that are likely to be driven by data and digitalisation.

1.2.3 Level of education and the labour market

Although not directly addressing technological unemployment, one of the policies adopted bythe government of South Africa was availing more funds towards higher education, to make it affordable to the marginalised and the less privileged citizens. Immense pressure has been exerted on the government of South Africa to provide free higher education through the "fees must fall movement" which began in 2015. The government has been trying to address the concerns of the movement by allocating more funds towards higher education. In the 2018 national budget, the government allocated three hundred and twenty-four billion rands to higher education while fifty-seven billion rands was allocated explicitly to 'fee-free' education in the next three years (National Treasury of South Africa, 2018).

Besides the increased access to education to secure a better future for the marginalised, the government financial support has also fueled increases in enrolments at higher education institutions. According to the UNESCO (2010), between the year 2000 and 2010, the enrolment in higher education in Sub- Saharan Africa increased from two million to five million students per annum. In South Africa, specifically, the latest statistics reported that total enrolments had risen by 41%, from 578 134 to 975 837, between 2000 and 2016 (StatSA, 2017). A further increase of approximately five hundred thousand more students by 2030 is expected.

Increased enrolments imply that the demands for jobs by graduates is increasing yet, looking at the unemployment statistics, the labour market has not been able to absorb all the graduates that are currently supplied by the universities (Harry *et al.,* 2018). The African Centre for Economic Transformation (ACET), (2016) also reports that 50% of graduates from over six hundred universities in Africa do not get employed due to lack of opportunities. The British Council, carried out a study in Ghana, Kenya, Nigeria and South Africa and confirmed increasing graduate unemployment. Graduate unemployment in Nigeria is 23.1% and 5.9% in South Africa. The proportion of unemployed graduates in Ghana and Kenya were not available but youth unemployment between the age of 25 and 29 years, which corresponds with the age of most graduates is 41.6% in Ghana and 15.7% in Kenya. The report further revealed that it takes an average of five years to find a secure job. Although graduate unemployment in South Africa is lower, there is a lower completion rate as 40% of the enrolled students drop out in their first year, and only 15% complete their degrees within the allocated time (McCowan *et al.,* 2014).

Some of the causes of graduate unemployment include lack of employability skills[1], studying in a field which is not in demand, poor curriculum, lack of relevant connections to the labour market and incompatibility between skills acquired and skills required on the labour market (Mncayi,2016; Kim *et al.,* 2014; Pitan, 2017).

In the context of South Africa, between 1995 and 2005, the labour market grew by 6.3 million new entrants while only 2.8 million jobs were created (Kraak, 2010). The South African economy has not been able to generate enough job opportunities for graduates (Broekhuizen, 2016; Oluwajodu, 2015; Kraak, 2010). This seems to be contrary to studies that suggest that obtaining a higher education qualification increases the probability to land at a job (Oluwajodu, 2015). Simultaneously, there is an assertion that the South African economy is experiencing a severe lack of skills (Oluwajodu, 2015). In essence, it implies that even if employment opportunities arise, employers are sceptical about hiring graduates because they lack adequate work experience. Likewise, hiring inexperienced graduates is perceived to be costly as firms would have to incur costs to train them (Kolesnikova and Kamasheva, 2015).

[1] Employability skills components include personal attributes, degree knowledge and understanding, work experience, career development learning, generic and emotional intelligence skills (Dacre-Pool and Sewell, 2007). The components are elaborated in chapter 2.2.1.1.

Against the backdrop of graduate unemployment caused by the skills gap and increased enrolments which is creating an oversupply of graduates, the fourth industrial revolution is reshaping the nature of work and the labour market. As demand for new skills is created, routine jobs are being eliminated (Ford, 2015) by machines and automated systems that teach themselves how to work with greater precision and efficiency (Schwab, 2015; Brown *et al.*, 2017). This is not only disrupting the labour markets but also the existing education systems (Marwala, 2017). Similar to other disciplines, the discipline of agricultural economics has to prepare for the changes confronting the labour market. There is, therefore, a need to review the curriculum to ensure it provides training that prepares the graduates for the expected changes in the workplace and that teaches the skills needed for the age of digitalisation.

1.3 Problem statement

As contextualised above, tertiary education is not only servicing a quickly changing labour market but is also functioning in an environment that is rapidly changing. In response to this, universities are increasingly tracing graduates' career paths as a tool to inform curriculum change and development. Notable recent tracer studies from around the globe support this view, see inter alia Pitan (2016) and McCowan *et al.* (2014). In South Africa in particular, changes impacting university programmes are demand and supply-driven. As mentioned earlier, from a supply side, a tertiary degree is perceived by the youth as the gateway to an improved standard of living. This, coupled with free tertiary education for low-income households, are expected to support the supply of graduates over the medium term. On the demand side, skills required by employers are rapidly changing with the digital revolution reshaping the nature of work in every sector of the economy and in some instances even reducing employment opportunities (Brown *et al*., 2017). It is expected that agriculture and more specifically, agricultural economics would not be exempted from these changes. The extent to which the digital revolution is affecting the agricultural economics profession in South Africa is, however, unknown. This set of circumstances warrants a tracer study to assess if the degree programme supply addresses the market demand. To this end, Ka Makhaya (2014) explored some of the supply and demand issues noted above. The study revealed certain skills are considered necessary for the success of agricultural economics from an employer and employee perspective and should be developed at the undergraduate level. The most noted skills

include advanced statistical and analytical skills, computer skills related to the analysis of data, and soft skills related to communication.

Findings from KaMakhaya (2014) therefore, touched on issues related to the digital revolution but stopped short of exploring it in greater detail. This study, thus, builds on findings from KaMakhaya (2014) by exploring the concept related to digital transformation in the workplace, explicitly.

1.4 Research objectives

The overarching objective of this study is to consider the extent with which digitalisation affects the functions typically performed by agricultural economists that graduated from the University of Pretoria. To achieve this, the specific objectives of this study are:

- To estimate the proportion of graduates who are employed and their perceptions of how their degrees contributed to their employability.
- To determine the familiarity of the University of Pretoria graduates with general digital technology concepts as a proxy for their propensity to adopt new digital technologies.
- To identify the key determinants of propensity to adoption by considering specifically years of experience and undergraduate academic performance.
- To reconcile their propensity to adopt digital technologies and their perceptions of digital technologies with the current curriculum structure.

1.5 Conceptual framework and hypotheses

The literature base on the adoption of digital advancements related to the fourth industrial revolution is expanding. However, many of the studies address the behavioural dimensions such as trust and attitude towards the adoption of these more advanced technologies, and how these technological advancements can improve or replace particular tasks. According to Czaja and Lee (2007), older and more experienced people tend to experience usability issues when using these more advanced technologies. These issues mainly relate to the design, complexity of commands and operating procedures of these systems as well as inadequate training, lack of instructional support, and a mismatch between the preferences of the users and the systems (Meyer, 2011). The study by Morris and Venkatesh (2000) revealed that older, and more experienced individuals were less inclined to adopt technologies based on their prior norms and beliefs, whereas younger, less

experienced individuals, because of their positive attitudes towards new technologies were more likely to adopt these. This finding was supported by Weinberg (2004) who that found that younger individuals with less experience are more likely to adopt new technologies.

The relationship between academic performance (education or GPA) and technology adoption has been researched quite extensively, in particular, the effect that technological adoption at school or university level has on the academic performance of learners and students (Jackson et al., 2008). Research on the impact of a graduate's academic performance on his or her likelihood to adopt digital advancements has, however, not been documented extensively. According to Riddell and Song (2012), more educated individuals are likely to adopt advanced technologies faster than those that are less educated. However, the findings could only be related to tasks that could be routinised in the workplace and not to higher-order tasks. In this study, the interest is particularly on how academic performance affects one's propensity to adopt technology. Based on the evaluated literature, it can be derived that the academic performance and the years of work experience a graduate has can influence their adoption of digital technologies. To that end, the following conceptual framework is proposed (Figure 1.1).

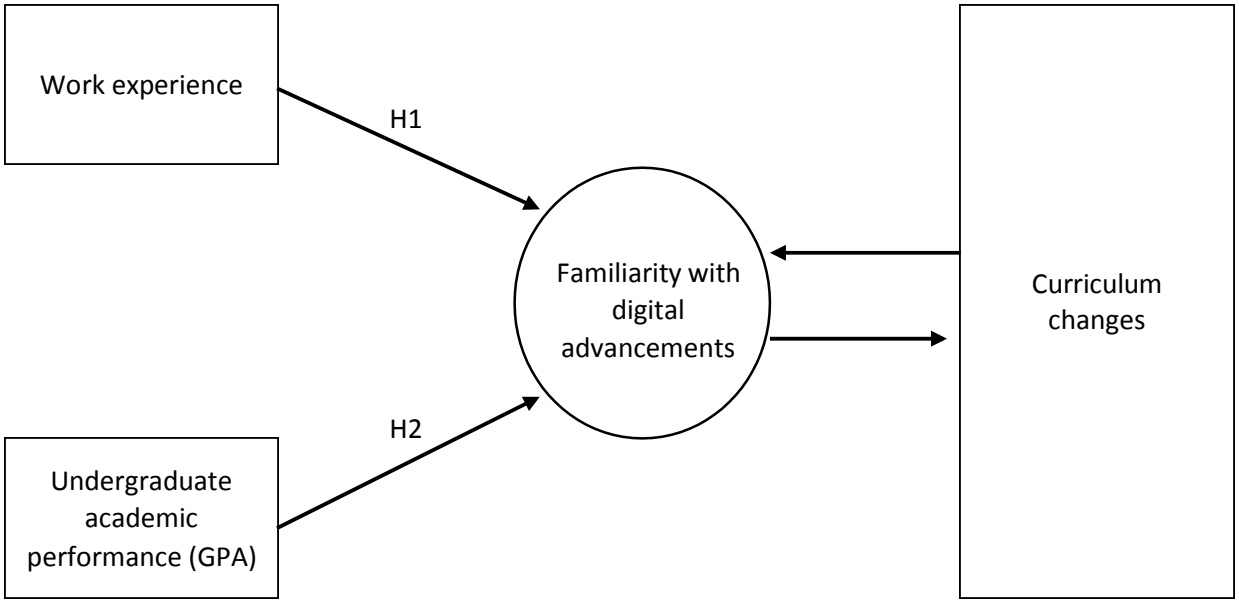

Figure 1.1: Conceptual Framework

From the conceptual framework, the following two hypotheses can, therefore, be derived to address the objectives highlighted above:

H1: There is a negative relationship between the years of work experience a graduate has and the familiarity with digital advancements

H2: There is a positive relationship between the academic performance of a graduate at the undergraduate level and their familiarity with digital advancements

1.6 Research methodology

1.6.1 The study context and the sample

The study focused on the University of Pretoria graduates from the Department of Agricultural Economics, Extension and Rural Development. This Department was established in 1928 and is seen as one of the oldest Agricultural Economics departments in South Africa, which implies that the department has over eighty cohorts of graduates.

A sample was drawn from the population of students who graduated from an undergraduate programme in Agricultural Economics in the 2013 to 2017 cohorts. The focus on this recent group of graduates was two-fold. Firstly, since the study builds on (Ka Makhaya, 2014), the study started to consider cohorts that were not included in her study. Secondly, more recent cohorts are more likely to have sound recollections of the programme offered at the Department to relate their perceptions on digitalisation and how their studies have prepared them for it. Telephone calls were made to ask for the graduates' participation and for their updated email addresses. Out of 165 graduates, only 76 could be reached on their mobile phone numbers available in the Department's database, which means only 76 graduates were included in the study.

1.6.2 Research instruments

The research utilised a tracer study based approach to develop a questionnaire. A tracer study is a retrospective standardised empirical form of a survey conducted by a higher education institution. Similar terms that are used to refer to it are; alumni survey, graduate career tracking, follow-up study or graduate survey (Schomburg, 2016). According to Badiru and Wahome, (2016), the main objective for a tracer study is to measure the midterm and long term impact of a higher education institution study programme. The study is conducted after graduation or right at the end of training to trace the activities of the graduates. There are several areas that the study covers but the most common ones are; study progress, the transition to work, current occupation, and application of

acquired competencies (Teichler, 2018). Tracer studies also provide information useful for accreditation of degree programmes, showing the uniqueness and individual positioning of an institution and, noteworthy for this study, explaining the link between a study programme and the labour market demands (Badiru and Wahome, 2016). The questions used in this particular study were adopted from the tracer study surveys used by Schomburg (2016) and KaMakhaya (2014). The majority of the questions were close-ended.

1.6.3 Data collection

The questionnaire was designed with Qualtrics to collect primary data. Qualtrics is a research and survey software that is widely used by the University of Pretoria. One of the advantages of using it is that it allows the researcher to extract socio-biographic data of the respondent such as year of enrollment, age, gender, nationality, race and home language from the Department's database. These data points exist because prospective students provide this information when applying for admission at the University. As a result, the questionnaire could be shortened as the researcher already had access to the socio-biographic data of the respondents.

Before administering the questionnaire, it was pre-tested with 10 graduates who are furthering their studies at the University of Pretoria. By testing the questionnaire, unclear questions were identified, and the necessary adjustments were made. The final questionnaire that was used is provided in appendix A.

The survey was done online with a notification to participate in the study sent to graduates during October 2018, followed by a link that directly took the participants to the questionnaire. Out of the 76 identified participants, 50 respondents completed the online questionnaire. Online surveys save time as they can reach thousands of people in a short time, is cheaper than printing questionnaires on paper, responses are automatically documented and made available to the researcher instantly and can be analyzed at an early stage so as to have an overview on how the survey is progressing (Wright, 2005). However, online surveys are prone to low response rates compared to interviewer-administered paper-based surveys (Nulty, 2008). Other limitations of online surveys include; sample bias as the sample is limited to internet users, cooperation problems as respondents might not be fully engaged in the survey, and less reliability since there is no certainty if the one who provided answers is the sampled respondent (Wright, 2006).

1.6.4 Analytical techniques

By default, Qualtrics provides the collected data in Excel spreadsheets. The data was cleaned and checked for consistency in Excel and then analyzed using STATA version 14. Most of the data were categorical data so descriptive statistics were used to present the main findings that address the objectives of the study. Inference testing through regression analysis was also employed to address the hypotheses of the study. This was achieved by asking the respondents to rate their familiarity with certain digital technologies, after which a familiarity score could be calculated.

A familiarity score is calculated to measure how familiar a certain brand, product, company or celebrity is known in a population. The metric that is generated from quantifying familiarity is called the Q score. The score was developed in 1963 and is widely used in marketing. The purpose that the metric serves include;

- Enabling the quantification of subjective concepts as familiarity and influence of a product, brand or celebrity;
- measuring the potential influence that the product, brand or celebrity might possess;
- Helping marketers to decide on the best product or celebrity to use for product endorsement or film role (Balik, 2010 and Zolides, 2017).

To calculate the metric, respondents are provided with options to rate their familiarity with a certain item or celebrity being surveyed. For example, the choices might be *A- Favourite; B- Good; C-Fair D-Poor.*

The formula for the Q score is;

$$Q\ score = \frac{favourite}{known} * 100$$

Where 'favourite' is the number of respondents who picked option A, and 'known' are all the respondents.

Alternatively, the Q score or familiarity score can simply be calculated by simply rating familiarity on a scale of 1-5, depending on the provided options (Balik, 2010).

Therefore, to determine the familiarity of certain digital technologies among the respondents, the familiarity score was calculated, and the calculations are provided in section 5.1. Work experience

(experience) and academic performance (GPA) were regressed with familiarity score as the dependent variable.

1.7 Justification of the study

The main purpose of this study is to use the perceptions of agricultural economics about the fourth industrial revolution to gauge the profession. The study determines the extent to which digitalisation affects the functions typically performed by agricultural economists that graduated from the University of Pretoria by looking at the perceptions and the prevalence of digital technologies in their workplace, and their proficiency to cope with current and future transformations. Learning from the graduates' experiences is a necessary input required to advise curriculum revision and necessary action for the future of the agricultural economics discipline. According to Kirsten, (2011), to decide on the future course of action for the agricultural economics discipline, there is a need for critical self-reflection to gauge the health of the discipline. Constantly reviewing the curriculum content enables universities to reconcile the demand and supply of skills on the labour market (Mocanu et al. 2012, Quinlan and Sayed 2016).

The findings of the study could be used to inform curriculum revision so that the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria keeps producing highly competent graduates that are in high demand by the labour market in the digital age. Moreover, the findings of the study will contribute to the existing literature on teaching and learning in the agricultural economics discipline in South Africa.

1.8 Outline of the study

Chapter 2 reviews the literature on factors that affect and contribute to graduate employability. It further discusses the fourth industrial revolutions and its manifestations that are both beneficial and detrimental to the labour market and the society at large.

Since the study is on the discipline of agricultural economics, Chapter 3 gives an overview of the attributes, evolution and the future of the discipline, and highlights the curriculum followed in the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria.

Both chapter 4 and 5 present results and discussion of the study. Chapter 4 focuses on the perceptions of the graduates about the degree programme and its contribution to employability. Chapter 5 presents results on perceived impacts of the fourth industrial based on the graduates' experiences on the job. Descriptive statistics on big data, automation, artificial intelligence and blockchain technology and robotics are provided in this chapter.

The final part, Chapter 6, provides a summary, conclusion, and recommendations based on the main findings of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a discussion of the literature relevant for this study. The first section discusses the factors that lead to graduate employability by considering the most popularly used model that ought to guide higher education institutions in designing curricula that promotes employability. Employability is the primary mission of higher education and is inspired by prevailing shifts in the labour market, such as that caused by the digital and fourth industrial revolution concepts. Therefore, the second section in this chapter provides a discussion from the literature on the fourth industrial revolution and its general socio-economic impacts. The last section focusses on the impacts of the fourth industrial revolution on employability.

2.2 Graduate employability

There have been growing concerns over graduate employment and employability over the years (ACET, 2016; McCowan *et al.,* 2014). Employment and employability are two different concepts that should not be interchangeably used (Dacre Pool and Sewell, 2007). Employment refers to the acquisition of a job (Koning et al., 2016), whilst employability refers to skill set, personal attributes and subject knowledge and understanding that enables one to acquire and maintain a job, in response to several changes in the labour market (Koning *et al.*,2016; Knight and Yorke, 2002). According to Dacre-Pool and Sewell (2007), the basic components of employability are:

- Knowledge and attributes that make one employable.
- Career management skills, which include job search skills.
- Presentation skills that enable one to get a job which includes curriculum vitae writing, work experience and interview techniques.
- Personal circumstances such as family responsibilities.
- External factors, such as the status quo of the labour market.

The responsibility to impart graduates with employability skills lies in higher education institutions (Suleman, 2018; Harry *et al.,* 2018; Koning *et al.,* 2016). Thereby making employability the mission for higher education (Suleman, 2018).

2.2.1 The employability model

The fourth industrial revolution inarguably demands curricula changes (Butler-Adam, 2018), and it should be guided by a model that promotes employability. An employability model is expected to serve four purposes. Firstly, employability models are frameworks that should provide information to be considered and included in a study programme. Secondly, it should be understandable to the student, parents, academics and all actors that are involved in the promotion of employability. Thirdly, it should show the roles that higher education institutions and business should take to contribute to graduate employability. Lastly, other than serving students, it should be applicable to people confronted by redundant situations or during mid-life career changes (Dacre-Pool and Sewell, 2007).

Popular employability models include the DOTS model (Law and Watt, 1977), course providers model (Bennett et al., 1999), and the USEM model (Knight and Yorke, 2002) but the CareerEDGE model is the most widely used. The main elements of the DOTS model are Decision learning, Opportunity Awareness, Transition learning and Self-awareness (Law and Watt, 1977) and the model is an acronym of its elements. The fundamentals of the course providers' model include disciplinary content and skills, workplace awareness, and employability skills (Bennette et al., 1999). The USEM model is an acronym for Understanding, Skills, Efficacy beliefs and Metacognition (Knight and Yorke, 2002). Dacre-Pool and Sewell (2007) proposed the most widely used employability model, the CareerEDGE model, for graduate employability, as shown in Figure 2.1. The previous models were found to be complicated and lacking research support yet the CareerEDGE model managed to solve those problems thus gaining popularity over the other employability models (Sumanasiri *et al.*, 2015). Due to its popularity and superiority when it comes to research support, only the CareerEDGE model is discussed in this study.

2.2.1.1 Components of the CareerEDGE employability model

The lower tier of the model (Figure 2.1) is made of five key elements, namely: degree subject knowledge, understanding and skills, emotional intelligence, generic skills, career learning development and work experience.

Source: Dacre-Pool and Sewell (2007)

Figure 2.1: The CareerEDGE employability model

Degree subject knowledge, understanding of the discipline and skills are the biggest motivations for enrolling in higher education institutions. Enrolment enables one to study a specific discipline in depth, attain a degree and become gainfully employed (Dacre Pool and Sewell, 2007). Employers tend to judge graduates based on the successful completion of their degrees (Sumanasiri et al., 2015).

Employers seek graduates with well-developed generic skills. Generic skills are also known as transferable or core skills that support any discipline and can potentially be applied in a wide range of contexts (Bennette *et al.*, 1999). These include creativity, adaptability, flexibility, willingness to learn, good communication skills, working independently, working in a team, ability to work under pressure, good presentation, numeracy, writing skills, ability to pay attention to details, time

management, planning, coordination, and the ability to adopt new technologies (Dacre Pool and Sewell, 2007).

For one to be more employable, there is also a need for well-developed emotional intelligence. Emotional intelligence encompasses how one perceives, understands and manages emotions. Graduates with high emotional intelligence are well rounded, self-motivated and can exploit group dynamics to achieve organisational goals (Bandura, 2000), for they can motivate others thereby becoming effective leaders and productive managers (Dacre Pool and Sewell, 2007). Emotional intelligence competencies are not genetically fixed and cannot be automatically developed during early childhood (Sumanasiri *et al.,* 2015), but can be successfully taught in higher education institutions (Dacre Pool and Sewell, 2007).

After obtaining a degree, graduates need to be able to identify and explain their achievements to prospective employers. Moreover, they should be able to articulate how the employer stands to benefit from the graduates in applications, curricula vitae and interviews (Sumanasiri *et al.,* 2015). The ability to do so can be achieved through career development learning, which is crucial for graduates as they search for satisfying jobs (Dacre Pool and Sewell, 2007).

Some employers have high regard for work experience. They believe that graduates with work experience can easily reflect on their experience thereby articulating and applying what they have previously learnt on their current jobs (Dacre Pool and Sewell, 2007). According to Sumanasiri et al. (2015), the amount of work and life experience include the perceived value of work experience, a network of developed contacts and community involvement.

The rest of the model include reflection and evaluation, self-efficacy, self-confidence, self-esteem, and should lead to employability. Graduates need opportunities to reflect and evaluate their learning experiences to articulate their abilities. By reflecting and evaluating their abilities, the graduates will develop self- efficacy, self- confidence and self-esteem, which are essential links to employability (Dacre-Pool and Sewell, 2007).

The model informs planning of study programmes and interventions by higher education institutions, employers and stakeholders on what needs to be considered to promote graduate employability (Dacre Pool and Sewell, 2007). It is, therefore, in the interest of any institution to understand the causal relationship between a study programme and the labour market (McCowan

et al., 2014). A university study programme is designed to equip graduates with attributes that can land them a job and become highly productive and successful in the labour market (Mocanu *et al.*, 2014).

Employers have been showing general dissatisfaction over the skills, and competencies graduates possess (McCowan *et al.,* 2014). Despite efforts being made to develop skills and competencies, there is still a huge discontent with the quality of graduates produced by universities. There is a growing mismatch between what the graduates hold, against what employers require (Oluwajodu *et al.,* 2015). Moreover, some studies have described knowledge received at universities as impractical and lacking modern practices hence diminishing opportunities to land a job. (Oluwajodu *et al.,* 2015; Mocanu et al. 2014). According to McCowan *et al.*, 2014), beyond successful completion of knowledge degree modules, there is a lack of knowledge about the values, knowledge and skills that the graduates actually possess. Therefore, the extent to which graduate unemployment is caused by a skills gap or lack of jobs is still yet to be resolved.

Various studies have extensively investigated what the employers' perceptions are on graduate employability. Employers' feedback is important for influencing curricula development and adjustments because it provides information on the labour market (McCowan *et al.,* 2014; KaMakhaya, 2014; Mocanu *et al.,* 2014). When higher education institutions capture the employers' perspectives, they can establish a link between them and make the transition for graduates from these institutions to work better (Badiru and Wahome, 2016). Pegg *et al.* (2012), claim that employability goes beyond the skillset and attributes that one possesses, but rather include factors such as gender, social class and race which are beyond the applicant's control. To substantiate this claim, it is important to consider the graduates' perceptions of their employability. In summary, Table 2.1 below shows the findings from studies that have captured the factors that affect graduate employability from the graduates' perceptions.

Table 2.1: Factors affecting graduate employability

Context	Country	Key Findings	Authors
Students' perceptions of learning experiences and employability	United Kingdom	The students were of the opinion that they **need improvements** in: -Critical thinking -Job searching skills -Subject knowledge -Communication skills -Self-beliefs, self-motivation and self-esteem	Wharton and Horrocks (2014)
Graduates' and employers' perceptions of their employability	Nigeria	The graduates were of the opinion that their **employability is affected** by: -Poor curriculum -A poor learning environment with inadequate facilities -Inadequate collaboration between universities and employers -Lack of other professional qualifications other than degree qualifications -Inadequate work-related experience -Lack of guidance counselling and career service unit -Higher salary expectations	Pitan (2016)
Graduates' perceptions of what influences their employability	Kenya	Graduates perceived the following factors as **essential for employability**: -Institution's reputation and status -Availability of jobs of certain specialisations -Gender -Entrepreneurial skills -Family networks -Low economic growth	McCowan *et al.* (2014)
Exploring graduates' perceptions of factors that affect employability	South Africa	Graduates are of the opinion that their **employability is affected** by: -Curriculum issues -Poor socio-economic status -Poor education system -Institution reputation -Social connection in which student belongs to	Harry *et al.* (2018)

Table 2.1 is not limited to any specific discipline. Key findings on the employability of agricultural economists must be understood by considering the most recent studies (KaMakhaya, 2014).

2.3 Employability in the discipline of Agricultural Economics

Degrees of a multi-disciplinary nature, such as agricultural economics, have become relatively marketable because they equip graduates with the ability to adapt to a wide range of employment options with ease. A study conducted on the value of university degrees in the United States of America ranked agricultural economics as the 8th in employability out of 171 university majors (Carnevale *et al.,* 2011) and has proved to be more marketable than other degrees in agriculture (Artz *et al.*, 2013). Robinson et al. (2007), also acknowledges that transferable skills to a variety of situations in a workplace are a desirable skill set to employers. This is a typical trait associated with agricultural economists. Therefore, the multi-disciplinary nature of agricultural economics has enabled graduates to encroach on other disciplines and are employed in other sectors of the economy (Vink *et al.,* 2011). Agricultural economists thrive in a wide range of sectors because of their universal views and systematic thinking, which is embedded through agriculture (Kirsten, 2011). The employability of graduates outside the agriculture sector is an indication of the strength of the degree (Artz *et al.,* 2013) but there is a downside to it. The downside is explained by Kirsten (2011) when he elaborates that "*The public sector, academia, the agricultural sector and society, in general, are deprived of much- needed skills to work on problems of importance to society at large"* as most agricultural economists are being employed outside the sector where they are offered competitive salaries.

KaMakhaya (2014) conducted a study to ascertain if the agricultural economics training is equipping graduates with the skill set that is required by employers. The study focused on eight universities[2] across South Africa, which offer agricultural economics training. Interviews were conducted among the graduates, the Heads of Departments and the employers of these graduates. The study revealed that graduates are generally satisfied with the quality of training received at the respective universities, however, the graduates did highlight several issues that need improvement. Among other skills, graduates felt that their computer analytical and statistical skills were not fully developed (KaMakhaya, 2014). Advanced information technology (IT) and programming skills mentioned by Fleming et al. (2017), fall under computer analytical skills that KaMakhaya (2014) mentioned. Her findings could, therefore, suggest a disadvantage for agricultural economists in the

[2] University of Pretoria, Stellenbosch, University of KwaZulu Natal, University of Limpopo, University of Venda, Forthare University, University of Free State, University of North-West

digital revolution era, which provides further support for this study. Heads of Departments rated their graduates as highly competent and ready for work whilst employers highlighted the lack of interpersonal skills as an issue under agricultural economics graduates. The inadequately developed interpersonal skills highlighted by employers included positive work attitude, loyalty to the organisation, high moral and ethical standards, self-motivation, working without supervision, professional telephone skills and etiquette.

The findings of KaMakhaya's study (2014) gave an insight into the labour market requirements for the agricultural economics discipline in South Africa. Thijssen et al. (2008), claim that job requirements are increasingly becoming complex such that the half-life of the majority of the qualifications is becoming shorter. The half-life of a skill or qualification is the period it is in demand before it is replaced by an innovation (VanderVyver and Pelster, 2017). According to Brown and Thomas (2011) "*The half-life of a learned skill is 5-years this means that much of what you learned 10 years ago is obsolete and half of what you learned 5 years ago is irrelevant*". Although not exhaustive, employability models such as the CareerEDGE model discussed above provides a useful guideline to curriculum development which produces graduates who are prepared to tackle whatever the future presents on the labour market (Dacre Pool and Sewell, 2007). The manifestations of the digital and fourth industrial revolution are reshaping the labour market, thus affecting employability in its entirety (Brown *et al.,* 2017; Schwab, 2015). This, therefore, requires insight on the requirements of the labour market and swift action by the departmental heads and lecturing staff to ensure that graduates and university degrees do not become redundant.

2.4 The Digital Revolution and the Fourth Industrial Revolution

The digital revolution began circa the 1950s and 1970s with the digitization of information and communication, which has been continually developing to present day, and it begot the fourth industrial revolution (Dai, 2018). The third industrial revolution brought about the computer and the internet. On the other hand, the fourth industrial revolution is the interaction of technologies that integrate the digital, physical and biological domains. Although there are some arguments on whether we are still in the third industrial revolution or already in the fourth industrial revolution, it is clear that the third industrial revolution provided building blocks for the fourth industrial revolution (Caetano and Charamba, 2017).

The three main domains for the fourth industrial revolution technologies are digital, physical and biological (Caetano and Charamba, 2017; Schwab, 2016). Schwab (2016), provided common examples for every technological domain. The digital domain is what formed the third industrial revolution, and common examples in the digital technologies domain include the Internet of things (IoT), radio frequency identification and blockchain technologies. Expansion of the IoT enabled the digitization of the surrounding natural and physical environments. Examples provided under the physical technologies domain include autonomous vehicles, 3D printing, and advanced robotics. The biological domain entails developments that allow technology to connect with human bodies. Some of the developments have enabled gene editing, sequencing and engineering. The practical application and developments of the domains have given rise to major technological shifts such as, among others; artificial intelligence, automation and robotics and services. All these advancements are underpinned by big data. (Schwab, 2016).

2.5 Fourth Industrial Revolution Shifts

The fourth industrial revolution is giving rise to practical applications and developments that have already hit the mainstream society (Schwab, 2016), though some of the impacts are not yet explicitly evident, they are present (Caetano and Charamba, 2017). Some of the common examples include Uber, online banking and shopping, digital signatures, auto-response on emails, use of automated teller machines and Bitcoins.

The Global Agenda Council on the future of software and society conducted a tipping point survey in 2015. The survey identified 21 tipping points or moments when specific technological shifts would dominate global society. The target population of the survey constituted of 800 information and technology experts and executives who gave their perceptions on when some technological shifts will occur. Results of the respondents who were of the opinion that the shifts or tipping points would occur within 10 years or less were summarised. The respondents were asked to give their perceptions over date ranges from “it has already happened” to “20+ years” and “never”. The responses of those who answered 10 years or less were summarised to provide a global view of the significant changes that can happen between 2015 and 2025. Table 2.2 below shows the overview of the expectations in 2025.

Table 2.2: Tipping points expected to occur by 2025

Tipping points expected to occur by 2025	% of respondents who agreed
10% of people wearing clothes connected to the internet	91.2
90% of people having unlimited and free (advertising-supported) digital storage	91
1 trillion sensors connected to the internet	89.2
The first robotic pharmacist in the US	86.5
10% of reading glasses connected to the internet	85.5
80% of people with a digital presence on the internet	84.4
The first 3D-printed car in production	84.1
The first government to replace its census with big-data sources	82.9
The first implantable mobile phone available commercially	81.7
5% of consumer products printed in 3D	81.1
90% of the population using smartphones	80.7
90% of the population with regular access to the internet	78.8
Driverless cars equaling 10% of all cars on US roads	78.2
The first transplant of a 3D-printed liver	76.4
30% of corporate audits performed by AI	75.4
The tax collected for the first time by a government via a blockchain	73.1
Over 50% of internet traffic to homes for appliances and devices	69.9
Globally more trips/journeys via car-sharing than in private cars	67.2
The first city with more than 50,000 people and no traffic lights	63.7
10% of global gross domestic product stored on blockchain technology	57.9
The first AI machine on a corporate board of directors	45.2

Source: World Economic Forum (2015)

Table 2.2 above shows that 11 out of 21 technologies had at least 80% potential to reach their tipping points by 2025. Wearing clothes connected to the internet was highly expected, 90.2%, to occur by 2025. Having the first AI machine on a corporate board of director has the lowest expectation, 45.2%, of happening by 2025.

2.6 Socio-economic impacts of the fourth industrial revolution

From an optimistic view, the fourth industrial revolution will result in increased productivity, improved quality of lives and economic growth. Consumers have been benefiting the most from the fourth industrial revolution by increased access and affordability to the digital world. As a result, it has enabled consumers to do things such as e-hailing, listening to music, buying products

and watching movies remotely (Schwab, 2016; Brown *et al.*, 2017; Whitehouse, 2016). There are several socio-economic impacts of the fourth industrial revolution that are discussed in the sub-sections below.

2.6.1 Positive impacts of robotics

The use of robots is increasing across sectors from manufacturing to agriculture and retail and services for myriad tasks. Developments in robotics cannot exist without artificial intelligence (Schwab, 2016). The early adoption of robots was the use of automated teller machines (ATMs), which has increased efficiency in the banking sector (World Economic Forum, 2015). Advances in sensors enabled robots to collect data, understand the environment, and respond by engaging in a wide range of tasks (Schwab, 2016). In the agriculture sector, robots can now access information remotely and can connect with other robots via the cloud (Schwab, 2016). The information is used to build equipment that can assist with efficient and precise chemical, water, pesticide, seed plantation, harvesting and even field preparation. Harvest CROO robotics, has been helping farmers with picking and packaging strawberries in an attempt to close the increasing gap between the labour that is available and food demand (Panpatte, 2018). Other sectors that have invested in robotics include the household appliance sector where robot vacuum cleaners are used in homes as well as the health care system, where some robots have been developed to assist with surgical procedures or dispensing drugs (Stone *et al.*, 2016; Schwab, 2016).

2.6.2 Positive impacts of blockchain technologies

Cryptocurrency is the most popular application of blockchain technologies (Schwab, 2016). In 2015, the total worth of blockchain was US$20 billion (World Economic Forum, 2015) and surged to over US$200 billion throughout 2017 (Carson *et al.*, 2018). According to Ge *et al.* (2017), blockchain has gone beyond cryptocurrencies as organisations are considering the application of this technology across all sectors of the economy. The remainder of this sub-section presents some documented cases that can potentially utilise, or have already utilised the blockchain technology.

South Africa is one of the leading table grapes exporters to Europe. The end consumer in Europe wants to know if the grapes are safe to eat, if they are organic or not, the soil conditions they grew in and the labour conditions on the farm. Moreover, they would like to know if the certification of the grapes is authentic (Ge *et al.*, 2017). Although the information is available, there are chances

that it could have been altered by either the supplier or retailer (Kamilaris *et al.*, 2018). Blockchain technologies can potentially solve this problem as the recorded data on the table grapes cannot be changed once entered into the chain.

Humanitarian organisations are always searching for efficient and less fraudulent ways to distribute aid to the needy. The World Food Program successfully distributed blockchain-based food vouchers to ten thousand Syrian refugees in Jordan. The vouchers are redeemed using biometric data. The technology has helped to feed the vulnerable in a less costly way with few systematic risks (Kamilaris *et al.*, 2018).

2.6.3 Positive impacts of big data, artificial intelligence and automation

The advent of artificial intelligence began with the availability of big data from sources such as social media, science, government, business and e-commerce, which gives raw data for the development of machine learning approaches and algorithms (World Economic Forum, 2015; Schwab, 2016). There is so much data generated by today's communities that enable better and faster decision making as well as open access to data that is useful for innovation. Availability of big data has also enabled increased targeted advertising (Schwab, 2016).

There are three levels of artificial intelligence, which are: assisted intelligence, augmented intelligence and autonomous intelligence. Assisted intelligence improves the capabilities of human beings to perform better tasks that they are already doing. Therefore, it constantly needs human input intervention. Assisted intelligence is everywhere, and common examples include the use of Global Positioning Systems (GPS) navigation, using big data and complex algorithms to organise Facebook timelines, and the use of Google search and email spam filters (Brown et al., 2017). Augmented intelligence is the middle ground for artificial intelligence that is inspired by human beings. The field includes image recognition, natural language processing, machine learning and neural networks. It gets and goes beyond the level of human intelligence as it proposes solutions, can reason, understand complexities and think abstractly (Brown et al., 2017). Augmented intelligence has given rise to secondary economies such as Uber, food and goods delivery (World Economic Forum, 2015) and cyber-crime fighting whereby a system can differentiate between an account hacked and a client trying to access his bank account in a foreign location (Brown *et al.*, 2017). Autonomous intelligence, also known as strong artificial intelligence, is what gave rise to

automation (Schwab, 2016; Brown *et al.*, 2017). According to Schwab (2016), automation of tasks is the central economic effect of artificial intelligence. In transportation, automation powered the manufacturing of driverless cars, which can reduce driving stress, road rage and increase the mobility of older and disabled people (World Economic Forum, 2015).

However, there are growing speculations and concerns over the effects of the fourth industrial revolution on security and employability. The ubiquitous nature of artificial intelligence and big data-driven applications poses potential threats on privacy, trust and transparency as it is susceptible to cyber-crimes (Schwab, 2016).

2.7 Impact of the fourth industrial revolution on employment

Literature has given much concern on the depth of impacts of the fourth industrial revolution on the labour market (Schwab, 2016; Caetano and Charamba, 2017; Ford, 2013, Brown et al., 2017). According to Brown *et al.* (2017) report, artificial intelligence will affect where we work and how we work. If the benefits of artificial intelligence are inequitably distributed across industries, income levels, education, skills level, job types and geographic locations, it will result in social unrest and political upheaval (Whitehouse, 2017; Brown *et al.*, 2017).

The fourth industrial revolution is unlike the other industrial revolutions that humankind has experienced before (Schwab, 2016). Industrial revolutions usually cause unemployment in the inception stage and create demands for new skills but eventually result in prosperity as industries adapt and new jobs emerged (Ford, 2013; Caetano and Charamba, 2017). The most critical skills required during the first industrial revolution related to practical tradecrafts. In the second industrial revolution, work became less laborious, thereby making creative design and logical thinking, the most relevant skills. During the third industrial revolution, machines could not learn by trial and error, so they required instructions from human beings (Caetano and Charamba, 2017). Whilst in the fourth industrial revolution, machines can learn, teach themselves and requires less human interventions (Caetano and Charamba, 2017) leading to uncertainty around the need for humans and the potential effect on employment. Lorenz *et al*. (2015) provided a list of the top ten effects of the fourth industrial revolution on the nature of work as: big data-driven quality control, robot-assisted production, self-driving logistic vehicles, production line simulation, and smart supply

network, predictive maintenance, machines as a service, self-organising production, additive manufacturing of complex parts and augmented work, maintenance and service.

Caetano and Charamba (2017), claim that the industries most affected by the effects of the fourth industrial revolution are the low skill and labour-intensive industries such as agriculture and manufacturing. Ford, (2013), offered an example of how technological advancement made millions of jobs to disappear in the US agriculture and the manufacturing sectors. Workers had to adopt by acquiring new skills as they move from farms to factories while automation in the manufacturing sector resulted in the transition to a service economy. The application of big data will reduce workers needed for quality control while posing a demand for an industrial data scientist (Lorenz *et al.*, 2015). The same adoption strategy might not be effective in this era because it is not easy to turn an assembly plant worker into a data scientist (Schwab, 2016). However, Brown *et al*. (2017) and Schwab (2016) argue that the effects of the fourth industrial revolution will disrupt both blue-collar and white-collar jobs as some high skilled tasks can effectively be performed by automated systems. There is a need for policy interventions to ensure the even distribution of economic benefits and mitigation of potential threats of artificial intelligence and other concepts of the fourth industrial revolution (Whitehouse, 2016). Potential threats can be controlled because the fourth industrial revolution was developed by people for people; thus it can be controlled by people (Schwab, 2016). The government of the United States of America proposed policy strategies that can be implemented to distribute the benefits of specifically artificial intelligence equitably, whilst mitigating the negative effects. It proposed among others, investment in research and development, increasing minimum wage worker bargaining power as well as training the workforce for future jobs (Whitehouse, 2016).

Since the fourth industrial revolution concepts will bring about new labour skills demands, there is a need to educate and train citizens for future jobs and equip them with the needed skills (Whitehouse, 2016). According to principal human resources and strategy officers from leading global employers, some of the most relevant skills in the fourth industrial revolution include complex problem solving, critical thinking, emotional intelligence, creativity, human resources management, and negotiation and service orientation. Technological optimists and alarmists have not been saying much about employment skills required in the agriculture sector, despite it being a significant employer in developing countries (World Economic Forum, 2016).

Schwab (2016) also agrees that new models of education and skills should accompany all the disruptions that the fourth industrial revolution will bring. This begins with ensuring that primary education is accessible to all citizens at all levels and then prepare the citizens for future opportunities presented by the fourth industrial revolution. Although it is in the context of developed countries, the US also urged policymakers to ensure that social safety nets are updated so that workers can pursue job opportunities and explore support systems such as unemployment insurance (Whitehouse, 2016).

2.8 Conclusion

Through exploring literature, three key actors in curriculum development were identified in this chapter. These are the student, (who needs to be employed), the labour market, (which needs to employ), and the university (as a supplier to the labour market). Students enrol for university degrees with the expectation of acquiring skills that can contribute to their employability. The labour market demands certain skills from university graduates. The demands of the labour market are influenced by a myriad of factors such as the economic environment, government policies and technological changes. This research topic and chapter, however, focuses on the impact that technological changes have on the demand for labour. The technological changes brought about by the fourth industrial revolution has brought technological changes that are resulting in demands for new skills. To ensure that the requirements of the labour market and the expectations of the students are met, the university should have a strong curriculum whose development should be governed by a model that underscores the employability of its graduates. Therefore, this chapter reviewed, among other models, the CareerEDGE model, which provides a broader context for curriculum review. By so doing, the literature review highlighted the vital elements which include degree subject knowledge, understanding and skills, emotional intelligence, generic skills, career learning development and work experience. These vital elements must be considered as curricula are being adjusted to cater for the changes brought about by the fourth industrial revolution.

CHAPTER 3

THE DISCIPLINE OF AGRICULTURAL ECONOMICS

3.1 Introduction

This chapter zeroes in on the discipline of agricultural economics. The first section provides a concise discussion on what the discipline is about and the roles of an agricultural economist in the workplace. Understanding the roles of agricultural economists is essential in probing how much the profession will be affected by the fourth industrial revolution. There are speculations that the fourth industrial revolution will result in job losses (Ford, 2013; Brown *et al.,* 2017) and it has already been experienced in other professions such as law and journalism (Schwab, 2016). The legal profession has experienced artificial intelligence systems that can predict a legal outcome, conduct due diligence and analyse documents more efficiently than human beings (Deloitte, 2016). The journalism profession has been using automated systems which produce news in real-time by converting data into narrative text more proficiently and speedily than human beings. (Broussard *et al*., 2019; Schwab, 2016). As a profession, agricultural economics must also prepare for the future of the profession in the fourth industrial revolution era. Therefore, the second section looks at the training of agricultural economics in South Africa and then the University of Pretoria. It further looks at the enrolments trends in agricultural economics to get a picture of the magnitude of the discipline.

3.2 Evolution of Agricultural Economics

The agricultural economics discipline started in the 19th century from a narrow focus on farm management and record-keeping to sophisticated application of economic principles to crop and livestock production (Oyekale, 2017; Kirsten, 2011; Runge, 2006). The first department of agricultural economics was established in 1909 at the University of Wisconsin-Madison in the US (Runge, 2006). According to Mohamed (2018), the world economic depression of 1930 had relatively severe impacts on the agriculture sector. This made economists pay more attention to agriculture problems to mitigate the impacts hence motivating the fuller development of the

science of agricultural economics (Mohamed, 2018). The school of thoughts that beget the discipline was profit maximization and marketing strategies for agricultural commodities through collective bargains and collective governance structures (Runge, 2006).

Between 1960 and 1980, agricultural economics globally began to fragment into distinct categories, which are;

- Traditional agricultural economics, marketing, credit agribusiness, research, extension, and policy;
- Resource and environmental economics of land, water, soil conservation, marine economics, recreation and resource degradation;
- Rural economics and development;
- International economics of agricultural development and trade; and
- Consumer and food economics (McCalla *et al.,* 2010).

The splitting of the discipline was in response to economic, political, climatic social and technological changes that affected the agriculture sector (McCalla *et al.,* 2010; Oyekale, 2017). In South Africa, the discipline was established in 1925 at Stellenbosch University in 1925, focusing on on-farm management and prices. Both globally and in South Africa, the discipline has also broadened its focus to cover issues on food systems, rural communities, environmental and natural resources and also in response to economic challenges confronting the agriculture sector (Kirsten, 2011). In 1928, the University of Pretoria established the second agricultural economics department in South Africa. A detailed account of the global evolution and local, South Africa, of agricultural economics is given by Runge (2006) and KaMakhaya (2014) respectively.

3.3 Roles of an Agricultural Economist

Agricultural economists apply economic principles to acquire more information about the supply and demand of goods and services in the agriculture sector (Manning, 2008). Their work involves analysing activities that drive the agricultural economy, production levels and the distribution of raw materials, land, labour and machinery (KaMakhaya, 2014). They offer advice on increasing profitability and improving the welfare of rural farmers and communities (KaMakhaya, 2014).

There are paramount activities that an agricultural economist should carry out to inform and influence decisions by any agricultural and related sectors as well as determining indicators such as food prices and farm income. The activities include conducting research, financial management, analysing data, and forecasting, and dictating trends in economic activities. An agricultural economist can select an area of expertise such as crop and livestock science, environmental economics, policy analysis, agribusiness management, food safety, international trade, rural development and marketing systems (Manning, 2008).

The expansion of the discipline has synchronised it with other disciplines such as mathematics geography, law, ecology, sociology and institutional theory (Kirsten, 2011). As a result, agricultural economists can engage in a wide range of activities that at times seem unrelated (McCalla *et al.,* 2010) as they encroach on other sectors of the economy (Vink *et al.,* 2011). This makes agricultural economics multi-disciplinary (Kirsten, 2011). Carnevale *et al*. (2011), confirms that degrees of multi-disciplinary nature such as agricultural economics have become marketable because they equip graduates with the ability to adapt to a wide range of employment options. According to Kirsten (2011), agricultural economists thrive in other sectors because of their universal views and systematic thinking that is embedded through agriculture.

In the fourth industrial era, artificial intelligence will develop software and applications that learn from previous events, experiences and data to forecast on future events, processes and decisions, thereby making it easy to make conclusions. There are already artificial intelligent systems that can identify the cause and effect of an event using big data (Schwab, 2016). Since the roles of an agricultural economist include making predictions based on current and historical activities, what then happens to the profession when fourth industrial revolution elements that can perform the same task effectively, accurately and at reduced costs take over?

3.4 Agricultural Economics training in South Africa

Currently, there are eight universities offering training in agricultural economics, which are, Stellenbosch University, University of Pretoria, University of Free State, University of Kwazulu Natal, University of Limpopo, University of Venda, the University of Fort Hare and the North-

West University. The departments hold different names in their respective universities. The University of KwaZulu Natal, Stellenbosch University, and the University of the Free State named them 'Department of Agricultural Economics'. The North-West University and Fort Hare universities fall under the name 'Department of Agricultural Economics and Extension' while the University of Limpopo named it 'Department of Agricultural Economics and Animal production'. The University of Venda has named it 'Department of Agricultural Economics' and Agribusiness'. The University of Pretoria has named it ´Department of Agricultural Economics, Rural Development and Extension'.

Total enrolment at these universities at the undergraduate level is higher than at the postgraduate level (Machethe, 2016). Undergraduate degrees include BSc. Agriculture, BSc. Agricultural Economics, BSc. Agribusiness Management, BCom Agribusiness Management and B Agriculture, whilst postgraduate degrees include Honours, Masters and PhD degrees that are offered with the departments of agricultural economics.

In 2016, the universities of Pretoria and Fort Hare had the largest departments in terms of enrolments (Machethe, 2016) and there has not been any update since then. The department of agricultural economics, extension and rural development at the University of Pretoria currently offers a total of 2 programmes at the undergraduate level and 12 programmes at postgraduate level as indicated in Table 3.1 below. The undergraduate curriculum offers more than eight agricultural economics courses. A detailed undergraduate curriculum is provided in appendix B. Some of the topics covered in the courses include;

- Analysis and interpretation of financial statements,
- Financial modelling,
- Mathematical and econometric analysis,
- Econometric simulation modelling
- Linear programming,
- Price trend analysis
- Decision making under risk and uncertain circumstances
- Environmental valuation of natural resources
- Demand and supply patterns of commodity

Artificial intelligence systems and other fourth industrial revolutions innovations are addressing some of the objectives of the listed topics. Buchanan (2019), conducted a literature survey on artificial intelligence systems that include machine learning and deep learning and their potential to transform the financial service industry. Machine learning is an artificial intelligence application that uses algorithms to automatically optimize on extracting patterns from a vast amount of data. While deep learning is a statistical technique used to find patterns in huge volumes of data. He detailed machine learning application that can be used to analyse price trends and financial statements and explore commodity pricing strategies that match demand and supply (Buchanan, 2019). Moreover, there are both machine learning and deep learning technologies that can be used for econometric simulation, modelling, analysis and linear programming. Chakraborty and Joseph (2017), claim that machine learning and deep learning methods generally outperform traditional modelling in prediction tasks. Application of blockchain technologies has the potential to refine economic valuation of natural resources because of their ability to provide verifiable, immutable information on exchange and possession of natural resources (LeSeve *et al.,* 2018). The use of big data can help to inform better decision making (Flemish *et al.,* 2018). Buchanan (2019) also discusses robotics platform, Robo-advisor that offers automated financial advice.

Table 3.1: Academic programmes offered by the Department of Agricultural Economics, University of Pretoria

Undergraduate Academic Programmes	**Total**
BSc (Agric) Agricultural Economics and Agribusiness Management BCom Agribusiness Management	2
Postgraduate Academic Programmes	
Honours BCom (Hon) Agricultural Economics BAgric (Hon) Extension BAgric (Hon) Rural Development	3
Masters MSc (Agric) Agricultural Economics MCom Agricultural Economics MSc (Agric) Extension M Agric Extension and Rural Development M Agric Rural Development	6
PhD PhD in Agricultural Economics PhD in Environmental Economics PhD in Extension	3

Source: University of Pretoria Department website (2019)

The University of Pretoria has one of the most reputable departments in South Africa (Kirsten, 2011) and Africa (Hendriks, 2017). Since 2006 to date, the department has been able to host 80 masters' students from at least 16 African countries per year under the joint collaborative master's programme. The ability of the University of Pretoria to host the collaborative programme has ranked the department as one of the best (Hendriks, 2017). This, therefore, serves as a testament to the quality and the facilities that the University of Pretoria's department provides (University of Pretoria, 2019).

3.5 Summary

Chapter 3 provided a brief overview of the agricultural economics discipline in South Africa and its evolution. Runge (2006), Kirsten (2011) and KaMakhaya (2014), provided more details of the discipline's evolution and history. The discipline's evolution has been influenced by economic, political, climatic social and technological changes that confront the agricultural sector. The

chapter also provided a concise discussion of the roles of agricultural economists and the current status of its training in South Africa. The world is in the advent of disruptive technological changes that are likely to interfere with the duties of agricultural economists. While reviewing the roles of agricultural economists, it became apparent that some tasks are going to be automated, such as price trend analysis and financial modelling. In this vein, it is important to consider developing skills that can keep agricultural economists relevant and competent in the labour market.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of this study in six sections. The first three sections provide results and discussion of the first objective. The first objective seeks to estimate the proportion of graduates who are employed and their perceptions on how their degrees contributed to their employability. To achieve this, the chapter starts by presenting the socio-economic characteristics of the respondents. It further presents the perceptions of the graduates about the degree programme they have completed and its contribution to their employability

From the fourth to the sixth section, results that address the second and third objectives of this study are presented. The second objective sought to determine familiarity of University of Pretoria graduates with concepts related to general digital advancement. This can serve as a proxy for aptitude to adopt new digital technology. It is expected that their aptitude to accept general advancements will be closely linked to the adoption of digital technology in the workspace. The third objective pursued to identify the key determinants of propensity to adopt by considering years of experience and undergraduate academic performance. More results and discussions follow that summarises the perceptions of the graduates about the fourth industrial revolution.

4.2 Socio-economic characteristics of the graduates

The respondents were asked to provide their employment status, annual salary range, and if they had taken any further studies in addition to their first degree to characterize the graduates. This was in addition to gender, age, nationality and home language that was extracted from Qualtrics. Table 4.1 below shows the results of the socio-biographic data of the respondents.

Table 4.1: Socio-economic characteristics of the graduates (n=50)

Variable	Description	Results
Average age	Maximum age (years)	34
	Average age (years)	26
	Minimum age (years)	21
Gender	Female	54%
	Male	46%
Nationality	South African	70%
	Non-South African	30%
Home Language	Afrikaans	40%
	English	32%
	All South African languages excluding English and Afrikaans	14%
	Other (Non-South African)	14%
Employment status	Employed	92%
	Unemployed	8%
Annual gross salary range	Maximum range	R500 000-R600 000
	Average range	R200 000-R300 000
	Minimum range	less than R200 000
Further studies	Yes	82%
	No	18%

Source: Survey data (2018)

As shown in Table 4.1 above, the average age of the respondents was 26 years with the maximum age being 34 years and the minimum is 21 years. The study targeted graduates who had completed their studies between 2013 and 2017 because they have sound recollections of the programme. The majority of the respondents, 92%, are employed while, 8%, are unemployed. Fifty percent of the unemployed are pursuing their studies on a full-time basis but have at least been employed while the other 50% have been looking for employment. Generally, unemployment among young people between the age of 15 and 24 years is relatively higher than any other age groups which are eligible to work. High youth unemployment can be explained by insufficient skills and a general decline in aggregate demand for labour (Axelrad *et al.,* 2018). Similar reasons thereof can be used to explain the low unemployment rate among the respondents for this study whose average age is26 years. On the other hand, Wilson *et al*., (2007), allude age biased stereotype attributes unemployment among older workers as there are perceived to be less adaptable to changes in the

workplace than younger workers. The employment status of the surveyed graduates is shown in Figure 4.1 below.

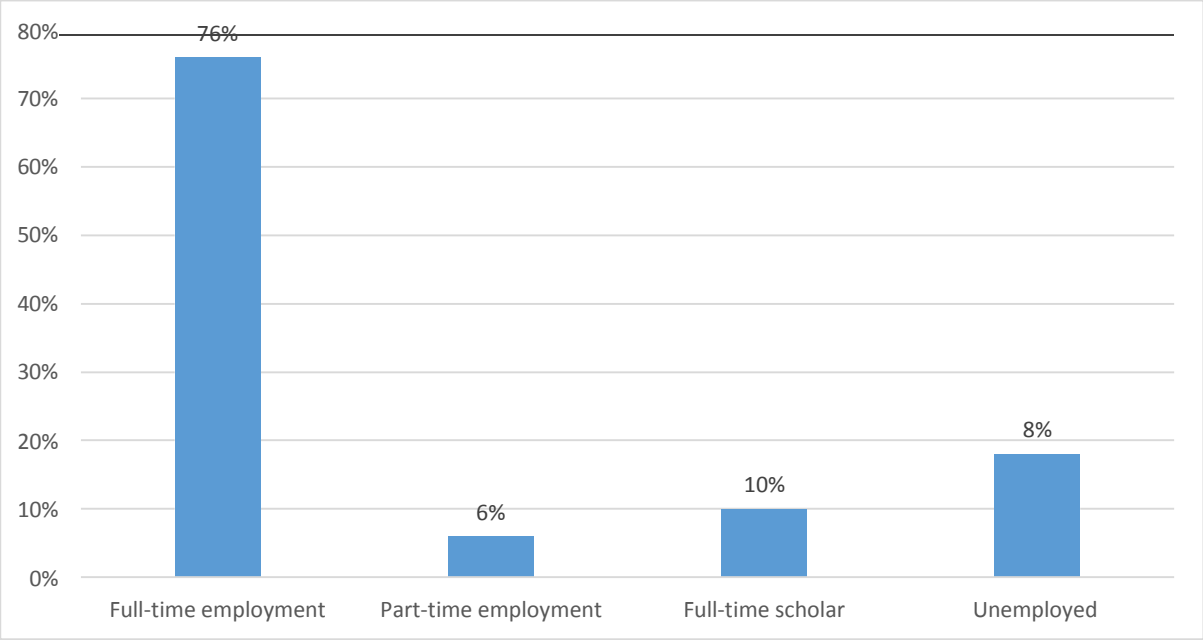

Figure 4.1: Employment status of the respondents

From Figure 4.1 above, 76% of the respondents are employed on a full-time basis, while 6% are employed on a part-time basis, and 10% full-time scholars. However, 8% of the respondents are unemployed neither employed nor pursuing any studies. A study conducted by Karatuna and Basol (2017), revealed that full-time workers are more satisfied with their jobs than part-time workers. Given the findings of Karatuna and Basol (2017), the majority of the graduates have job satisfaction.

Although most of the respondents were female, 54% while 46% were male, we cannot conclude that it is the reflection of the gender distribution in the agricultural economics industry. The industry has been known to be male-dominated (KaMakhaya, 2014). However, the findings of Machethe (2016), reported an equal gender distribution of the students enrolled for agricultural economics across all universities in South Africa. This might also suggest an equal gender distribution in the agricultural economics labour market.

The majority of the respondents, 70%, were South African citizens, while 30% are non-South African citizens. The findings of Machethe (2016) indicated that there more South African citizen students enrolling for agricultural economics at the undergraduate level than for postgraduate

studies. Along similar lines, the results of this study also revealed that there are more South African citizens among the respondents who completed their undergraduate degrees in agricultural economics. This might propose that South Africa can retain agricultural economists they need to tackle arduous challenges confronting the agriculture sector.

After obtaining a degree in agricultural economics, 82% of the graduates advanced their studies, and 18% did not. Out of the graduates who indicated that they furthered their studies, 51% of them did so for career development. According to Gill and Hoppe (2009), one of the objectives for furthering studies after obtaining the first degree is for development of current professions and also that others envision careers in academia hence enrolling for postgraduate degrees. The motivation behind studying further as indicated by 15% of the respondents was because it was required by their employer while 34% were trying to fill up time during a period of unemployment.

The most dominant home language of the respondents, 40% was Afrikaans. Similarly, most of the respondents in KaMakhaya (2014), used Afrikaans, 50% as their home language. According to KaMakhaya (2014), the dominance of the Afrikaans language among agricultural economics graduates proposes a need to develop strong communication skills in English (KaMakhaya, 2014). Part of the questionnaire had a section that required the respondents to give their suggestions on what can be incorporated into the curriculum to promote employability. Some of the respondents suggested that Afrikaans should be added in the agricultural economics curriculum as some job positions in the discipline require one to be bilingual.

Kirsten (2011), asserts that agricultural economics graduates get employed in different sectors of the economy other than the agriculture sector. To determine which sectors are employing most the graduates, they were asked to provide the sector they are currently employed in. From the results, the graduates were categorised into 3 main categories which include; Agriculture and Food Sector, Banking and Insurance, Public Sector and Research and all other sectors were grouped under "other". The distribution of the respondents is depicted in Figure 4.2 below.

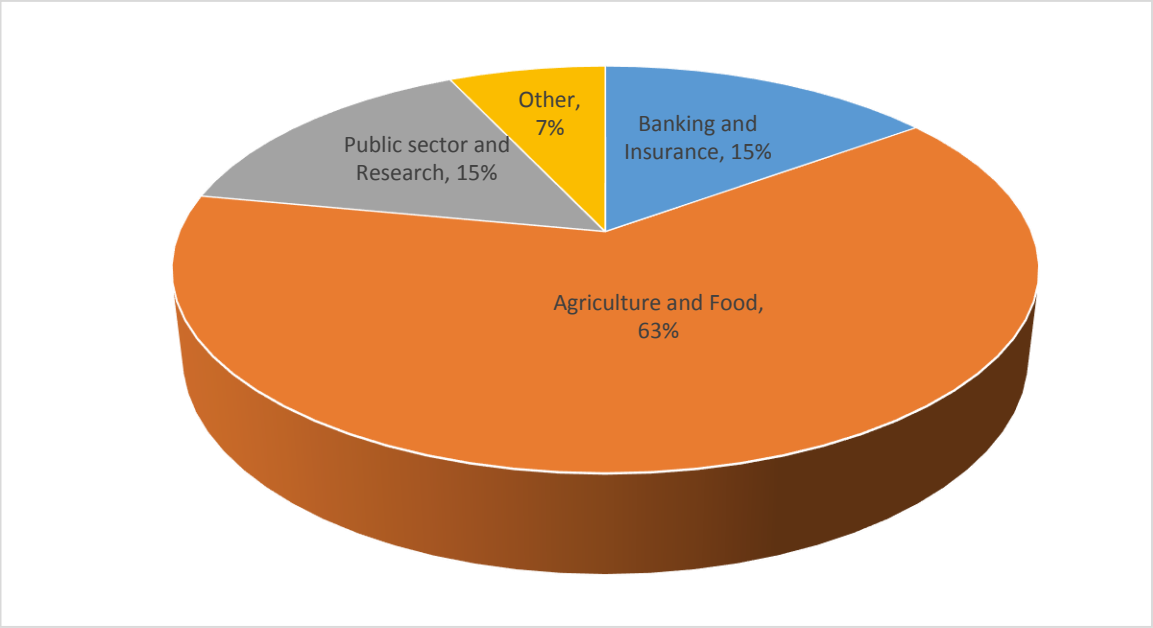

Figure 4.2: Distribution of survey respondents per sub-category

Average annual gross salary for most of the graduates is in the R200 000 – R300 000 range with the maximum range being R500 000 –R600 000. Survey respondents have been known for not accurately reporting their income (Micklewright and Schnepf, 2010), and there is a possibility that the maximum salary range might have been exaggerated or underreported. The respondents who earn above R300 000 indicated that they have more than one job and are above the age of 25. Some studies have proved a significant relationship between work experience and compensation, while some studies have proven otherwise (Dash *et al.*, 2017). Forty-four percent of the respondents have had at least two jobs since they completed their first degree in agricultural economics and all of the respondents are above the age of 26. The other 52% had not changed from their first job since they were employed and the majority of them are below the age of 25.

Beyond employability attributes, there are some factors that contribute to graduates' employment (McCowan *et al.*, 2014). This study, therefore, also found out how the graduates got their first job after graduation. Figure 4.3 below, is a representation of the results.

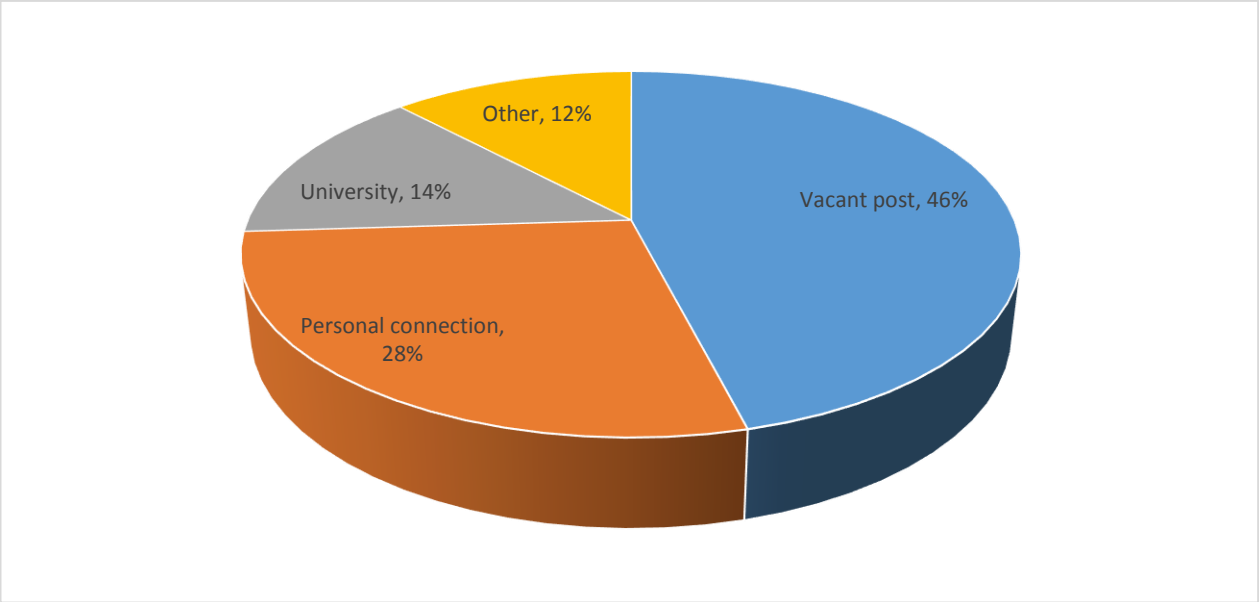

Figure 4.3: How respondents got their first job

A study conducted by Mncayi (2016), revealed that at times knowing people in influential positions can help open job opportunities for a graduate. Therefore, having personal, professional and political connections can play a significant role in the labour market (McCowan *et al*., 2014; Mncayi, 2016; Harry et al., 2018). The results in Figure 4.3 show that 28% of the respondents used their connections to get their first job. Moreover, some firms claim that finding graduates with the right skills to fill a vacant post is becoming difficult. The results of this study proved otherwise as a relatively large proportion of the graduates, 46%, percent indicated that they got their first job by applying to a vacant post. On the other hand, some graduates have poor search skills which affect their hiring (Mncayi, 2016). A survey of 1000 Australian university students had 75% of the respondents indicating that they need the university to help them find jobs (Ross, 2019). The results of the study revealed that 14% of the respondents were assisted by the university placement office to get their first job. This attests that the university is playing an active role in connecting its graduates with the labour market.

4.3 Degree programme and employability

Before making any recommendations for curriculum revision, it is important to have a view on how the current curriculum has been useful in equipping the graduates for the labour market.

Perceptions of the graduates about the attributes that contribute to getting a job, proficiency in basic agricultural economics and competencies were captured from the graduates.

4.3.1 Perceptions of graduates on the factors that landed them a job

On a Likert scale, the respondents were asked to rank the order of importance of factors they perceived to have contributed to securing their current employment. The results for the ranks for important and least important are presented in Table 4.2 below.

Table 4.2: Attributes that contributed to landing in a job (n=48)

Variable	Very important	Important	Average	Less important
Academic performance	21%	50%	2%	27%
Work experience	21%	38%	8%	33%
Reputation of the University	33%	33%	5%	29%
Reputation of the Department	19%	40%	10%	31%
Communication skills	67%	25%	8%	0%

Table 4.2 illustrates that 88% of the graduates ranked communication skills presented during the interview as the most important skill to the successful placement of their current jobs. Dacre-Pool and Sewell (2007) classify communication skills in interviews as one of the career development attributes. If a graduate does not communicate and market their knowledge and abilities to its prospective employer, the chances of getting employment are slim. A study by Olszewski *et al.* (2017) also proved that both verbal and non-verbal communication skills presented by a job candidate in an interview contribute to the employer's hiring decision. Academic performance was deemed to be an essential attribute in getting a job by 72% of the respondents. Along similar lines, Basir (2016), conducted a study on the relationship between academic performance and employability skills in Malaysia and the results proved that there is a positive relationship between the two attributes. A survey on graduate employability in Germany revealed that the most sought after skills in graduates by employers are soft skills while academic performance is the least important (Finch *et al.,* 2013).

Some employers have high preferences for graduates with work experience because they can easily relate and apply their previous experiences to their current jobs (Sumanasiri *et al.,* 2015; Dacre-

Pool and Sewell, 2007). The results in Table 5.2 substantiate the assertion as 64%; the respondents indicated that work experience is important in landing a job.

The reputation of a university can enhance the employability of graduates. A typical example is that there is a higher possibility that employers can show a high preference for graduates from Harvard University over graduates from other universities (Chevalier and Conlon, 2003). However, in a study conducted by Finch *et al*. (2013), the reputation of a university is the least essential factor employers consider in making a hiring decision. The results in Table 4.2 above however show that 68%, of the respondents, indicated that the reputation of a university is an important factor in landing a job.

4.3.2 Proficiency and employability

The graduates were asked to rate their proficiency in core skills specific to the agricultural economics discipline and the results are presented in Table 4.3 below.

Table 4.3 Proficiency in skills (n=50)

Skills	Excellent	Average	Below Average
Prepare a good project report	78%	12%	10%
Analytical and data management skills	72%	20%	8%
Farm budget	66%	26%	8%
Solid business plan	64%	34%	2%
Social media usage(Facebook, Instagram, LinkedIn, Twitter)	54%	24%	22%
Able to transact on SAFEX	36%	32%	32%
Computer programming	28%	28%	44%

Source: Survey (2018)

KaMakhaya (2014), compiled a list of skills that are most applicable in the workplace and graduates are expected to have obtained upon completion of their program. The skills are what the HoDs perceived to be important in the workplace. These included report writing, statistical analysis, preparing farm and enterprise budget on excel and transacting on SAFEX. Theresults in Table 4.3 above confirms the findings of KaMakhaya (2014) as it indicates that the majority of the graduates thought that they are highly proficient in preparing a good report, solid business plans, and farm and enterprise budgets on excel. Only 14% of the graduates in KaMakhaya's (2014)

study were proficient in transacting on SAFEX, but Table 5.3 above, showed 68% of the graduates have at least average skills in using SAFEX. Among other attributes, gaining knowledge, understanding and skills in a particular subject is crucial for graduate employability (Dacre-Pool and Sewell, 2007).

Among other skills, KaMakhaya (2014), indicated that computer programming was one of the skills that needed improvements over the next decade. However, KaMakhaya's (2014) study did not provide the proportion of the graduates who highlighted the need for improvements in computer programming. As shown in the table above, 44% of the graduates are of the opinion that they have below-average skills in computer programming, leaving over 50% with satisfactory skills in computer programming. This consequently poses a need to put more effort into developing computer programming skills.

Social media usage has increasingly become an area of interest for most organisations and scholars as marketers are making use of it to contact customers, share information and surveillance on related products (Distaso, 2012; Whiting and Williams, 2013). It is expected of an agricultural economics graduate to have market know-how, and research skills (KaMakhaya, 2014) and social media are becoming a useful marketing tool. A study conducted in the United States of America revealed that most of the top and largest companies use social media for operating both internally and externally (Distaso, 2012). Some of the social media technology covered in Distaso, (2012) included Twitter, LinkedIn, Facebook, Youtube, Flicker, Wiki, Blogging, Video, Podcasting and Myspace. In this regard, graduates were asked to rate their proficiency in social media usage, and only 24% indicated that they have below-average skills in social media usage while the majority of the graduates have at least standard skills. This proves that most of the graduates know how to navigate on social media.

4.4 Familiarity with digital concepts

To determine respondent's aptitude to accept digital technologies as part of their job, consumers were prompted to rate their familiarity with certain digital technologies that are pervasive and have changed society and the way we do business over the past 20 odd years. Eleven of these technologies were included in the survey and are listed below:

- Google Maps

- Facebook
- Spotify
- Online Shopping Platforms
- PayPal
- Uber
- Online banking/ App
- Online Check-In when flying
- Netflix
- Online Assistants
- Automatic Brakes

Google maps are one of the many interactive digital maps used for navigation. A study conducted by a US company revealed that 77% of smartphone owners use google maps (Ranko, 2018), making it relatively popular. A study surveyed 9000 internet users in 22 countries, including South Africa. It reported that 96% of South Africa's online population use digital maps which represent about 50% of the total population. Using digital maps such as google maps saves 7% of travel time valued at R11 million and has supported around R456 billion in sales in 2016. Furthermore, the information on digital maps has enabled users to do their shopping efficiently thereby saving 100million hours per year valued at R5 billion (Alphabeta, 2017).

Facebook is one of the popular social networking sites. Social networking sites are defined as internet-based platforms which are created and designed for communication, collaboration and sharing of content (Thurairaj *et al*., 2015). Among other social networking sites such as Instagram, WhatsApp, Twitter, Facebook is the most popular. Statista, a German online statistics portal, reported that Facebook had 2.3 billion users in 2018 worldwide making it the most popular social networking site. South Africa had 16.2 million Facebook users in 2018 (Clement, 2019a).

Spotify is a digital music streamlining service that offers users a wide range of music content. It is the most popular music streamlining service in the world. Between 2015 and 2017, the cumulative time spent on Spotify worldwide was 40.3 billion hours (Watson, 2019a). In South Africa, it was launched in 2018, and its market base has been growing beyond expectation though no statistics have been disclosed (Shapshak, 2019).

Executing commercial transactions of goods and services through electronic channels such as the internet is referred to as e-commerce. Online shopping is a form of e-commerce (Sharma and Batra, 2016). In 2018, South Africa's online shoppers spent R45.3 billion in online shopping and predicted to rise to R61 billion by 2020. Moreover, 62% of the online shoppers purchased something from an overseas online retail shop in the same year. Some of the overseas transactions were paid through universally recognized and trusted payment options as PayPal (Clement, 2019b; Paypal, 2018).

PayPal is an online payment method which allows for online transfers and payment processes for online retailers and other commercial users. It is the most popular payment option worldwide, with 287 million active users globally and recorded an annual payment volume ofover US$578 billion in 2018. Seven percent of South Africa's online shoppers prefer it over other online payment methods (Clement, 2019b).

Uber is a ride-sharing mobile app that allows drivers to share their spaces with passengers for a fee. In 2018 it had 95 million users worldwide (Mazareanu, 2019a) and over 1 million users in South Africa (Business Insider, 2019).

Online banking- Online banking refers to self-service platforms which enable consumers to conduct their banking without human interference (Muzofa, 2015). A study conducted in 17 countries with a sample size of 17 100 consumers revealed that 73% of the respondents use online banking at least once in a month (Srinivas and Wadhwani, 2018). In South Africa, 35% of internet users have access to internet banking (We are social, 2018).

Netflix is one of the most popular media streaming services in the world. Thirty-seven percent of internet users in the world subscribe to Netflix (Watson, 2019b). In 2018 it had 152 thousand subscribers in South Africa and was projected to have over 337 thousand subscribers in 2020 (Statista, 2016).

According to a Statista report by Mazareanu (2019b), 50% of airline passengers, including South African passengers, checked in on-line while travelling.

Automated online assistants like chatbots and other voice assistants as SIRI and Google Now are becoming popular in the world for bringing real-time and 24/7 customer service. An estimated 70% of millennials around the world reported positive feedback from their chatbots experience

(Comm100, 2019). A global poll conducted on chatbot adoption revealed that 80% of the businesses in South Africa, France and the Netherlands are willing to adopt chatbots for customer service by 2020 (Tezer, 2018).

According to the United Nations Global Goals and the Decade of Action for Road Safety (2011), technologies as automatic braking systems have the potential to reduce deaths caused by collisions. South Africa has been adopting much of the technologies and is encouraged to be legislated (Ward, 2019).

The respondents were asked to rate their familiarity with the following concepts between the following options: A – *I own it/use it*; B – *I know someone that owns it/ uses it*; C – *I have heard of it*; D – *I have never heard of it*. Respondents were scored a 1 for each option listed as A, 2 for B, 3 for C and 4 for D. A lower score was therefore associated with higher familiarity with a high score indicating low familiarity. Scores ranged from 11 (listed all A's for each technology) which implies the highest familiarity to 44 (listed all D's for each technology) which implies the lowest familiarity. The distribution of the scores is shown in Figure 4.4 below.

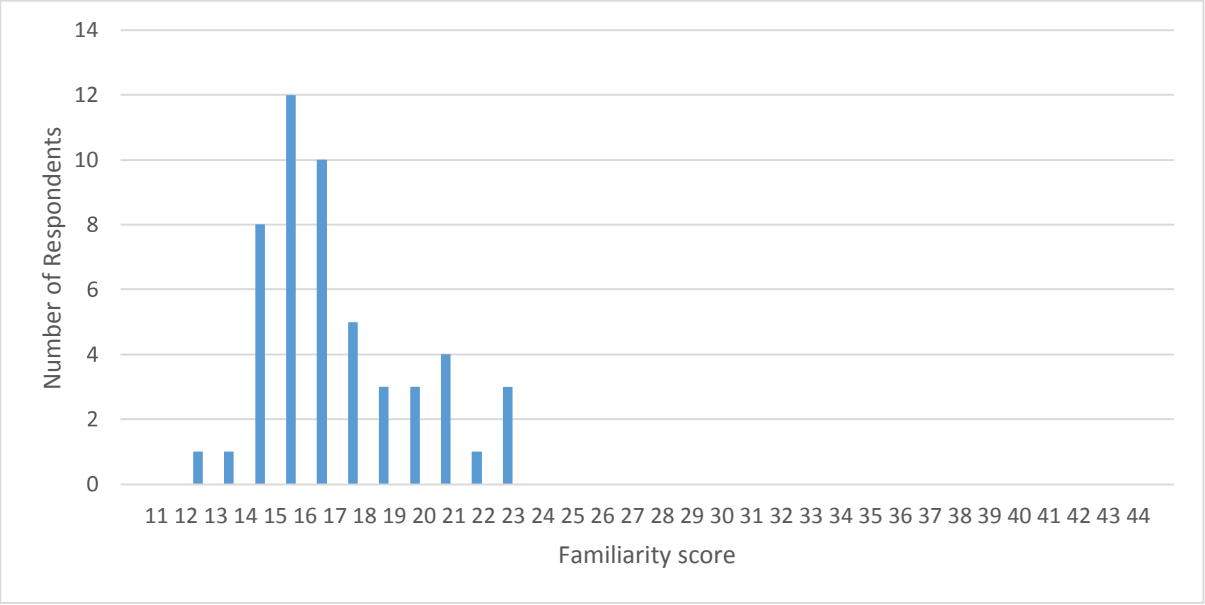

Figure 4.4: Score distribution of familiarity with digital advancements

From Figure 4.4, it is apparent that the scores follow a normal distribution and they are positively skewed to the "familiar" end of the spectrum with the mean score being 17.5 and the scores ranging between 13 and 23. If familiarity with digital tools is used as a proxy for an aptitude for adopting new technology (on a personal

level and in the workplace), the results presented above do seem to suggest that the graduates considered here are not fully versed in digital advancements. To consider the academic and vocational factors that could influence familiarity with digital adoption, average undergraduate GPA and years since graduation were considered. Years since graduation serves as a proxy for professional experience (Czaja and Lee, 2007; Meyer, 2011; Morris and Venkatesh, 2000; Weinberg, 2004; Jackson *et al.*, 2008; Riddell and Song, 2012). The latter variables were regressed on the familiarity score discussed above. The results from the Ordinary Least Squares (OLS) estimation are presented in the table below.

Table 4.4: Estimation results from OLS estimation (Dependent Variable = Familiarity Score)

	Coefficients	**p-value**
Intercept	6.901903	0.001265
EXPERIENCE	-0.206597	0.224974
GPA	0.0252	0.495707

The results in Table 5.1 above tested the two hypotheses of this study. The first hypothesis states that; there is a negative relationship between the years of work experience a graduate has, and the familiarity with digital advancements. The coefficient, (-0.206597), suggested that there is a negative relationship between years since graduation and familiarity with digital technologies but not statistically significant in explaining the variation in the dependent variable. We, therefore, rejected the null hypothesis and concluded that the more experience one has, the higher is their aptitude for adopting new technologies.

Academic performance was the other independent variable used. The second null hypothesis states that; there is a positive relationship between the academic performance of a graduate at the undergraduate level and their familiarity with digital advancements. The positive coefficient, (0.0252) proposed a positive relationship between academic performance and familiarity with digital technologies. However, the relationship is not statistically significant because the p-value (0.495707) is not significant at all levels of significance (1%, 5% and 10%) in explaining the familiarity. We, therefore, rejected the null hypothesis and concluded that the graduate's academic performance could not be used to determine the graduate's aptitude to adopt new technologies.

One of the factors that influence the speed of adoption for digital innovations is word of mouth. A study by Jahanmir and Cavadas (2018), revealed that there is a positive correlation between the negative word of mouth and late adoption of technology innovations. (Jahanmir and Cavadas, 2018). Moreover, other factors that contribute towards the adoption of digital technology innovations include perceived benefits, ease of use and beliefs (Muriithi *et al.*, 2016; Jahanmir and Cavadas, 2018; Fleming *et al.,* 2018). Therefore, the next section, 5.2, presents results on the perception of the graduates about the fourth industrial revolution.

4.5 Perceptions on the prevalence of the digital revolution concepts on current jobs

The respondents were asked to give the extent they perceive big data, automation, artificial intelligence robotics, and blockchain technology will feature in their current jobs in the next year, 5 years and 10 years. They were asked to respond using the following options; *A-large extent, B-Some Extent, and C-less to No extent at all*.

The majority of the respondents in the sample space reported more on the large extent option; therefore, only the results on a large extent are reported below. The extent to which the concepts will feature in jobs of the graduates differs by sector.

4.5.1 Perceptions on the prevalence of big data on current jobs

The graph below, Figure 4.5, presents the perceptions of the graduates on the extent big data will feature in their jobs in the next year, 5 years and 10 years.

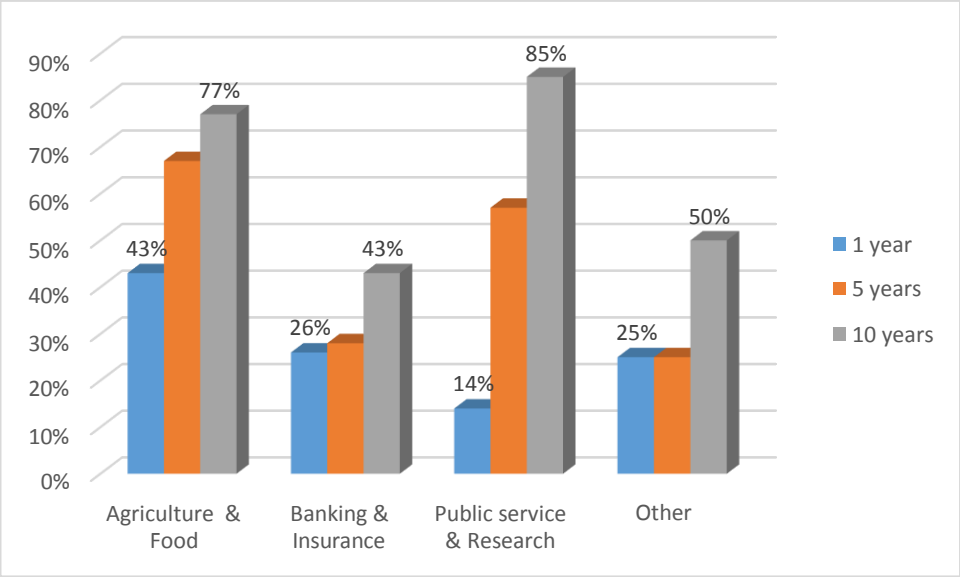

Figure 4.5: Perceptions of the prevalence of big data in jobs over the next decade

Graduates are of the opinion that as years ensue, big data will feature to a large extent in their current jobs across all sectors. Of the graduates employed in the agriculture and food sector, 77% perceive that they will experience the phenomenon to a large extent in the next 10 years. This the group where the highest number of respondents, 43%, believe that big data will interfere more with their current jobs in the next year. Several studies postulate that big data application in the agriculture and food sector has significant potential to address issues of sustainability, resource efficiency, productivity, food safety, waste reduction and supply chain optimization (Poppe *et al.*, 2015; Ribarics, 2016; Bronson and Knezevic, 2016). These are some of the issues that agricultural economists employed in the agriculture and food sector tackle hence perceiving increased use with time.

In the next year, 43% of the graduates employed in the banking and insurance sector foresee big data featuring more in their current jobs. The banking sector is one of the sectors that is confronted by huge volumes of data that come from customers' complaints, feedback, transactions and other services they offer (Jain and Bhatnagar, 2016). The use of big data can help banks to gain competitive advantage, reduce operational costs, transform challenges to opportunities and minimize risks in real-time (Amakobe, 2014). Therefore, it is expected that big data usage in the banking sector will increase with time. According to Amakobe (2014), the exposure to big data is

not similar across all banks as some have had hands-on experience with live big data while others are still piloting and experimenting with big data.

Fourteen percent of the graduates employed in the public sector and research indicated that big data would feature to a large extent in their current jobs. The proportion was projected to increase by 71% over the next 10 years. The role of the government sector is to uphold domestic tranquility, attain sustainable development, secure basic rights, and promote the general welfare and economic growth for its citizenry. All this can be achieved by decision-making processes that involve consulting with different actors, and the process requires so much data. (Kim *et al.*, 2014). Thereby making big data an indispensable tool ofgovernment goals. Hence it is expected that big data will be continuously used in the public sector and research.

4.5.2 Perceptions on the prevalence of automation on current jobs

The graph below, Figure 4.6, shows the results of how the surveyed sample perceive automation to feature in their current jobs in the next year, 5 years and 10 years.

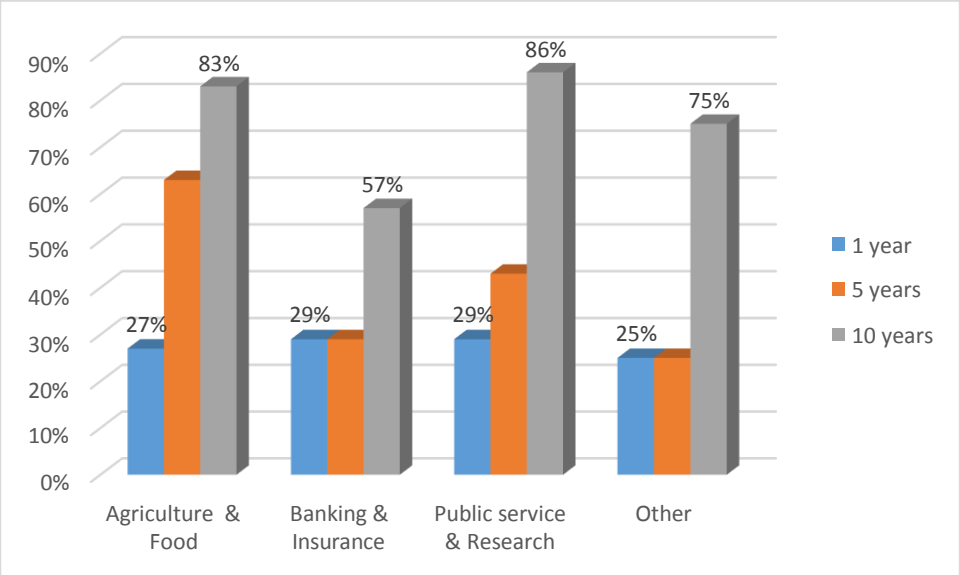

Figure 4.6: Perceptions of the prevalence of automation in jobs over the next decade

Similarly, like big data, automation will feature to a large extent in the jobs of the respondents as time progress. In a 10-year period, the extent to which the graduates perceive automation will

feature in their current jobs will increase. The percentage change[3] for those employed in the agriculture and food sector will increase by 56%, 28% for those employed in the banking and insurance sectors, 57% for those in the public sector and research, and 50% for those employed in other sectors of the economy. The banking and insurance sector has the lowest percentage perceived increase compared to other sectors. An article by (Berruti *et al.*, 2017) highlighted the setbacks that the banking sector is encountering with automation. The setbacks can be summarised as follows:

i. Although some banks have installed software programs that automate repeated tasks, there is very little to show for it in terms of efficiency and effectiveness;
ii. Some banks launched several pilots without any long term plan hence resulting in challenges and confusion in scaling;
iii. Other banks have employed program and software developers to work on solutions but have been unable to implement the solutions;
iv. Failure to implement the solutions is partly attributed to lack of capabilities required to implement the solutions (Berruti *et al.*, 2017).

Therefore, this might justify the low percentage change of graduates who perceive that automation will feature in their jobs to a large extent in the next 10 years. Conversely, automation of banking practices in South Africa has resulted in the closing of many branches and massive job losses. In a news interview, the Chief Executive Officer of Standard Bank in South Africa acknowledged that they had closed 90 branches and retrenched over 1000 employees between 2018 and 2019. The main reason for the closures is because most of their customers are using digital banking options resulting in a 25% decline in the number of visits to branches (SABC news, 2019). This might suggest that the respondents of this study who are employed in the banking sector might have not foreseen the changes during the time they were surveyed for this study. In another newspaper interview, the secretary-general of the South African Society of Bank officials (Sasbo), claimed that banks are digitalising and replacing workers without informing the employees beforehand (The South African, 2019). The low percentage change perceived might be an indication that the roles assumed by agricultural economists employed in the banking sector are not

[3] The percentage changes or increases were obtained from the difference between the perceived impact in the next year and the next 10 years.

affected rapidly. The public sector and research present the highest percentage change, 56%, on the extent that automation will be experienced in their jobs between the next year and 10 years. In the initial stage of automation, most governments managed to make a significant investment in ICT and are evidenced by advancements in creating online processes for citizens to complete applications and communicate with service providers (Ameen and Ahmad 2017). According to (Mawela *et al*., 2017), investments in ICT in the government sector manifests itself as electronic government, E-government. In Africa and other developing countries, E-government projects have the potential to address administrative and development problems even in areas with low literacy rates as rural areas. Rural India provides a typical example whereby access to services can be facilitated by voice recognition, thereby improving access of the illiterate (Schuppan, 2009). Therefore, these expectations can justify the reason why graduates employed in the public sector and research perceive that automation will increasingly influence their jobs in the next 10 years. However, it is noteworthy that due to poor infrastructure and institutional conditions in Africa, E-government projects might take longer to prepare and implement (Schuppan, 2009).

The most popular impact perceived by graduates as a result of automation is that it will make work easier across all sectors. Seventy percent of the graduates employed in the agriculture and food sector, 72% in the banking and insurance sector, 42% in the public sector and research, 75% in other sectors share the same sentiment. The findings are in line with literature which claims that automation makes work easier as it will replace mundane routine tasks (Brown *et al.*, 2017; Schwab, 2016). Only 14% of the graduates employed in the banking and insurance sector and 3% of those employed in the agriculture sector are of the opinion that automation can cause employment gain. According to Hawksworth *et al.*, (2018), automation has the potential to create more job opportunities by boosting productivity and creation of better products and services. This will consequently result in creating wealthier and larger economies. (Hawksworth et al., 2018).

Seventeen percent of the graduates employed in the agriculture and food sector, 14% in the banking and insurance sector and 29% in the public sector and research are of the opinion that automation will result in employment loss. Caetano and Charamba, (2017), claim that the most affected cohort by automation and other fourth industrial revolution concepts are the low skill and labour-intensive industries such as agriculture and manufacturing. However, Caetano and Charamba (2017), referred to low skilled employees in the agriculture sector and this study interviewed high skilled

employees who have at least a degree. On the contrary, the results above showed that employment loss is mostly perceived by those in the public sector and research. The implementation of e-government projects might be perceived as leading to job losses by government employees.

4.5.3 Perceptions on the prevalence of artificial intelligence on current jobs

Figure 4.7 presents the perceptions of the graduates about how much artificial intelligence will feature in their current jobs over the next decade.

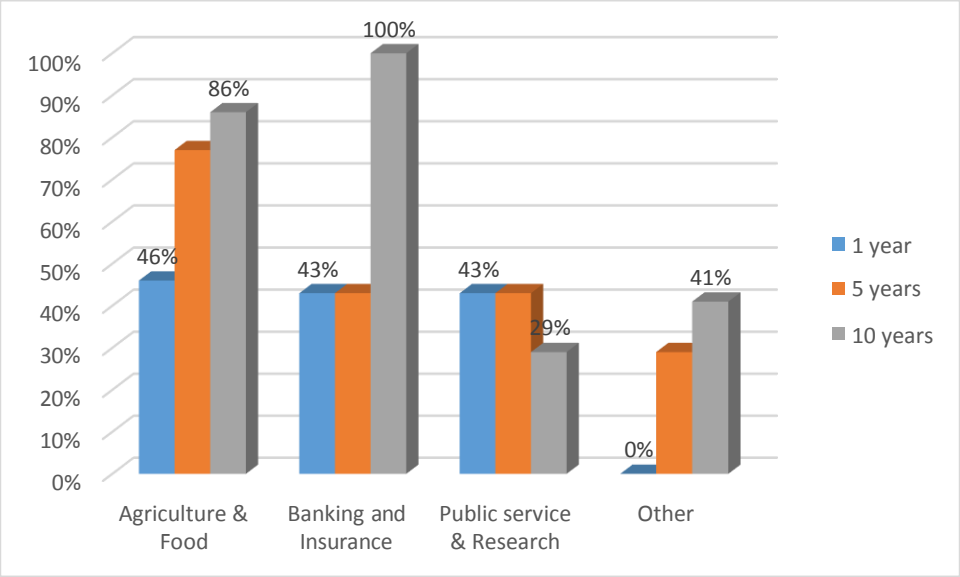

Figure 4.7: Perceptions on the prevalence of artificial intelligence in jobs over the next decade

All of the graduates, 100%, employed in the banking and insurance sector, are of the opinion that artificial intelligence will feature in their current jobs over the next decade. The banking sector has been increasingly adopting artificial intelligence techniques for seamless customer services. Some of the techniques include use of chatbots to resolve customer queries and analysing customer's transactional data to monitor fraudulent activities (Vedapradha and Ravi 2018).

The prevalence of artificial intelligence in the agriculture and food sector is perceived to increase by 56% over the next decade. The increase is in line with findings in studies which supports the increased need for adoption of artificially intelligent systems for efficient agricultural practices that result in increased productivity. There are artificial intelligence systems that assist with

analysing farm data, thereby providing information for decision-making (Murase, 2000; Smith *et al.*, 2009).

Between the next year and 10 years, graduates who are employed in the public sector and researchers are of the opinion that artificial intelligence will feature less by 14%. The findings are not in line with most studies as governments need more artificial intelligence to improve and augment their services to society (Makridakis, 2017; Eggers *et al.*, 2017). According to Enago Academy (2018), the benefits of artificial intelligence in academic research include;

- Through organising papers by content rather title, researchers can easily identify trends in research;
- Identify potential peer reviewers from online sources which journal editors would not be aware of;
- Help the researcher identify funding sources;
- Identify flawed reporting and statistics;
- Combat plagiarism (Enago Academy, 2018).

4.5.4 Perceptions on the prevalence of blockchain technology on current jobs

The results of how the graduates perceive blockchain will interfere with their current jobs are presented in Figure 4.8 below.

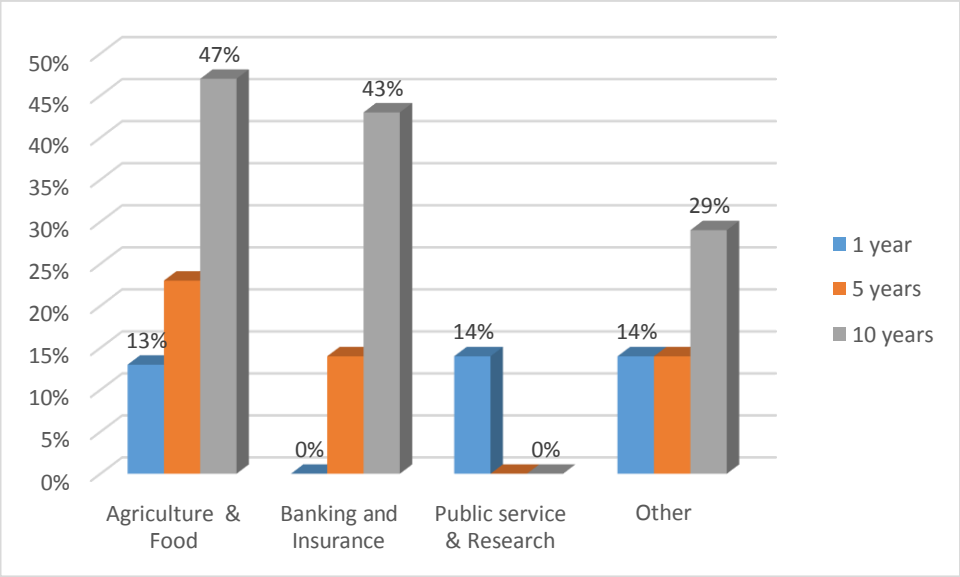

Figure 4.8: Perceptions on the prevalence of blockchain technology in jobs over the next decade

The agriculture and food sector has information management problems (Ge *et al.*, 2017). There are documented cases of unauthentic and fraudulent information in the agri-food sector. Some of the high-profile cases include the European horsemeat scandal of 2013 whereby horsemeat was discovered in processed beef (Manning *et al.*, 2016) and the halal meat scandal where pork was discovered in halal products (Fuseini *et al.*, 2017). In 2018 South Africa recorded the biggest listeriosis outbreak originating from consumption of processed meat products (Hunter-Adams, 2018). Producers, retailers and consumers need verifiable information on market and pricing, the origin of the product, quality of the product and any other information pertaining food safety and integrity (Ge *et al.*, 2017; Vander Merwe, 2012; Munsaka, 2018). The humanitarian community needs transparency on food aid distribution to achieve food security (Kamilaris *et al.*, 2018). Blockchain technology can solve information transparency and integrity issues since it provides immutable permanent transactions. Along the supply chain, blockchain technology can help with food certification authenticity, traceability of products and tracking the origins of products (Kamilaris *et al.* 2018; Ge *et al.*, 2017). Therefore, it is expected that as we progress, the agriculture and food sector will need blockchain technology to solve information management problems. Similarly, the results in Figure 4.8 shows that over time, the graduates perceive that blockchain technology will feature more in their jobs, by 34% over the next decade.

With blockchain technology, global remittances can be facilitated with fewer transaction fees. The technology will most likely gain more popularity in the banking sector as it allows for peer to peer transactions without involving the bank as a third party, use of automated bank ledgers and digital assets. Therefore, it is expected that its applications are going to be wider in the banking sector (Cocco *et al.*, 2017; Peters and Panayi, 2015; Shah *et al*., 2018). The findings of the study presented in Figure 4.8 show that the graduates perceive a 43% increase in the use of blockchain technology between the next year and 10 years.

The graduates who are employed in the public sector and research are of the opinion that blockchain technologies will feature more in their jobs in the next decade. The extent to which it features in their current job will decrease by 14% in the next 10 years. Since blockchain technology holds the promise of making processes more efficient, transparent and democratic (Shah *et al*., 2018), the public sector and research are expected to use it more. The use of blockchain in government can improve government services and reduce fraudulent activities (Deloitte, 2018).

4.5.5 Perceptions on the prevalence of robotics on current jobs

Figure 4.9 presents the results on the extent that robotics is perceived to feature in the graduates' current jobs.

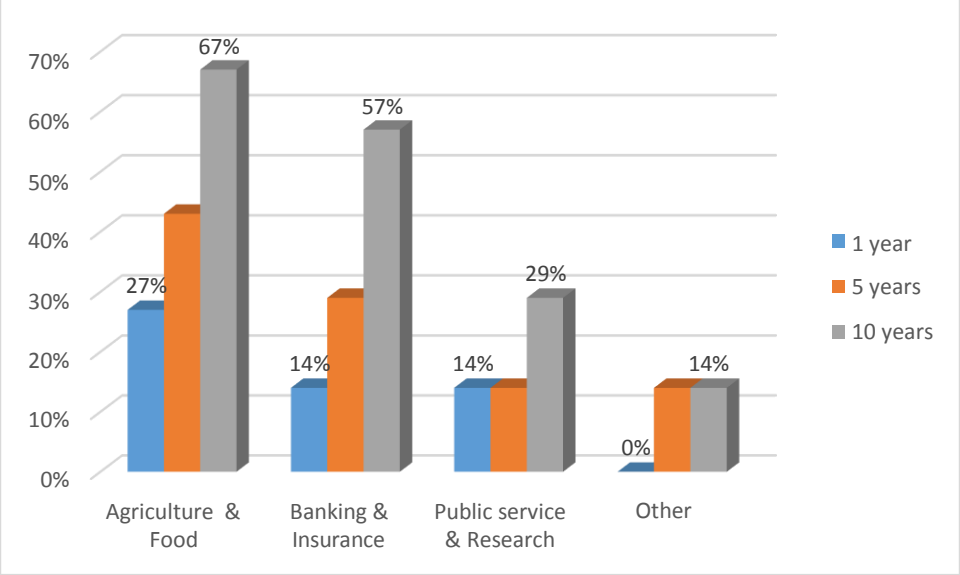

Figure 4.9: Perceptions on the prevalence of robotics in jobs over the next decade

Graduates employed in the agriculture and food sector have the most prominent opinion on how robotics will interfere with their current jobs. Sixty-seven percent of them indicated that robotics would feature to a large extent in their current job in the next 10 years. Lowenberg-DeBoer (2018) asserts that the increased demand for robots in agriculture is driven by the need for alternatives to human labour and the growing environmental and food safety concerns. According to Adelaja (2003), agricultural economists provide advice on increasing profitability and productivity to a farmer. In this vein, an agricultural economist can advise a farmer to make use of robots for efficient harvesting which will cut down their labour costs hence increasing their profitability. While the farmer's profits increase, a lot of farmworkers will lose their jobs yet farm employment is the main source of employment in the rural areas. On the other hand, the focus of agricultural economists is on improving the welfare of rural communities (Adelaja, 2003) which constitute of the people who are losing their jobs to robots.

In the next 10 years, the prevalence of robotics within the banking and insurance sector is perceived to increase by 43%. The banking and insurance sector is always trying to improve customer experience, reduce costs and augment their productivity. Robots have been identified as a way to improve the banking sector by providing efficient customer service, giving financial advice and detect fraudulent transactions (Oliviera and von Hippel, 2011).

For graduates employed in the public sector and research, 29%, are of the opinion that robotics will increasingly feature in their current jobs to a large extent over the next decade. Van der Wal and Yan, (2018) suggested that robots can be better government leaders that can be helpful in flawless decision making. The suggestion proposes that the application of robotics in government might end up encroaching in the politics of a nation (Van der Wal and Yan, 2018). Although the respondents of this study are not politicians, the political status of a nation has an impact on their work and the agriculture sector.

4.6 The perceived effect of the digital revolution concepts on the nature of work

Several studies have given attention to how innovations and developments of the fourth industrial revolution will affect the nature of work. Unquestionably, the nature of work changes with every industrial revolution. Jobs are eliminated while others are created. Inevitably, newly created employment opportunities create a demand for new skills (Schwab, 2016; Caetano and Charamba,

2017; McCowan *et al.*, 2014). Table 1.1 provided a summary of the skillset demand that came with every industrial revolution.

To gauge the graduates' perceptions on the effect of the fourth industrial revolution on employment, the graduates were asked how digital concepts will change the nature of work. They were provided with the range of the following options to choose from:

A. Employment gain

B. Employment loss

C. Creating demand for new skills

D. Making work easier

E. No impact.

Table 4.5 summarises the perceptions of the graduates on how the nature of work will be affected by big data, automation, artificial intelligence, blockchain technology and robotics. Their responses are presented respective of the sector the respondents are employed. The table also includes a column on the perceived change in the prevalence of the concepts in the next decade.

Table 4.5: The effect of the digital revolution concepts on the nature of work (n=46)

Big data	**Employment Gain**	**Employment loss**	**Shifts in demand**	**Work easier**	**No impact**	**Change in 10 years**
Agriculture &Food	26%	3%	7%	**37%**	27%	+34%
Bank & Insurance	0%	36%	0%	**40%**	24%	+17%
Public sector & research	24%	0%	0%	**44%**	32%	+71%
Other	50%	0%	0%	25%	25%	+25%
Automation						
Agriculture &Food	3%	17%	10%	**70%**	0%	+56%
Bank & Insurance	14%	14%	0%	**72%**	0%	+57%
Public sector & Research	0%	29%	29%	**42%**	0%	-14%
Other	0%	0%	25%	75%	0%	+50%
AI						
Agriculture &Food	10%	26%	27%	**37%**	0%	+56%
Bank & Insurance	14%	30%	13%	**43%**	0%	+28%
Public sector & Research	0%	24%	29%	**43%**	0%	+57%
Other	0%	20%	21%	33%	0%	+50%
Blockchain						
Agriculture &Food	7%	0%	**43%**	16%	33%	+34%
Bank & Insurance	14%	0%	**57%**	0%	29%	+43%
Public sector & Research	17%	0%	**43%**	14%	29%	-14%
Other	17%	0%	**67%**	17%	0%	+15%
Robotics						
Agriculture &Food	3%	**40%**	53%	3%	0%	+40%
Bank & Insurance	0%	**57%**	43%	0%	0%	+43%
Public sector & Research	14%	**43%**	43%	0%	0%	+15%
Other	0%	**50%**	33%	0%	17%	+14%

The perceived effects of the digital revolution concepts on the nature of work per industry are discussed in more detail in the sections to follow.

4.6.1 Perceived effects of big data on the nature of work

A relatively large proportion of the graduates, 37% working in the agriculture and food sector, 40% in the banking and insurance sector, 44% in the public sector and research and 25% in other sectors perceive that big data will make work easier. Moreover, all the sectors perceive an increased prevalence of big data within their current jobs in the next 10 years. The prevalence of big data with the jobs of those employed in the public sector and research is expected to increase by 71% in the next decade. Together, these results might suggest that making work easier is the most professed change as a result of big data application by agricultural economists. Several researchers have claimed that big data application will result in an optimized decision-making process, increased efficiency and effectiveness at minimal costs and faster speed to markets across all sectors of the economy (Huberty, 2015; Poppe *et al.*, 2015; Fleming *et al.*, 2018; Bronson and Knezevic, 2016).

Despite the increased change perceived in the prevalence of big data with current jobs, a substantial proportion of the respondents indicated that big data would have no impact on the nature of work. There were 27% graduates employed in the agriculture and food sector, 24%, in the banking and insurance sector, and 32%, public sector and research sectors who indicated that big data would not impact their work in any way. This, therefore, suggest that the graduates might be having a superficial understanding of big data such that they cannot foresee the issues related to an analytical capacity that will bring about changes in the workplace.

Employment loss is perceived by 36% of the respondents employed in the banking and insurance sector and 3% in the agriculture sector as a result of big data. Online and mobile banking options have resulted in a reduction of customers visiting bank branches leading to the closing of branches and massive job losses. Only 7% of the graduates employed in the agriculture and food sector are of the opinion that big data will result in shifts in the skills demanded on the labour market. Employment gain is perceived by 26% of the graduates employed in the agriculture and food sector, 24% in the public sector and 50% in other sectors. Manyika *et al.* (2011), estimated an increased demand for professionals who possess statistical and predictive analysis skills and a further 1.5 million global demand for managers who have adequate skills to manage information generated by big data. Although the discussion of big data hugely focused on data scientists, there is a greater need as all professionals are required to adapt to the phenomenon (Miller, 2014). This,

therefore, confirms that there will be shifts in skills set demanded on the labour market even though the findings of the study had a very small proportion of the graduates who perceive the change. Application of big data will reduce workers needed for quality control while posing a demand for industrial data scientists (Lorenz *et al.*, 2015). Since it is not easy to turn an assembly worker into a data scientist (Schwab, 2015) increased utilisation of big data is likely going to lead to employment loss.

4.6.2 Perceived effects of automation on the nature of work

Seventy percent of the graduates employed in the agriculture and food sector, 72% in the banking and insurance sector, 42% in the public sector and research and 75% in other sectors share the same sentiment. These findings are in line with literature which claims that automation makes work easier as it will replace mundane routine task (Brown *et al.*, 2017; Schwab, 2016). According to the graduates, in the next decade, automation is perceived to be more prevalent by 56% in the agriculture and food sector, 28% in the banking and insurance sector, 57% in the public sector and research and 50% of those employed in other sectors.

Only 14% of the graduates employed in the banking and insurance sector and 3% of those employed in the agriculture sector are of the opinion that automation can cause employment gain. Automation has the potential to create larger economies and consequently create more jobs (Hawksworth *et al.,* 2018). Seventeen percent of the graduates employed in the agriculture and food sector, 14% in the banking and insurance sector and 29% in the public sector and research are of the opinion that automation will result in employment loss. Caetano and Charamba (2017), claim that the most affected cohort by automation and other fourth industrial revolution concepts are the low skill and labour-intensive industries such as agriculture and manufacturing. The results above showed that employment loss is mostly perceived by those in the public sector and research. Clerical tasks as data capturing have a high risk of being automated hence resulting in employment loss.

Only 3% of the graduates employed in the agriculture and food sector perceive employment gain as a result of automation. Studies have shown that most of the employment opportunities that will be created are in line with data science, will be created for data scientists (Hawksworth *et al.,* 2018;

Manyika *et al*., 2011). Agricultural economics graduates do not yet comprehend these changes and therefore, do not perceive this as gains in employment.

4.6.3 Perceived effects of artificial intelligence, blockchain technology and robotics on the nature of work

Perceived impacts of artificial intelligence in this study are employment gain, employment loss shifts in demand for skills, and making work easier. Studies have claimed that artificial intelligence will disrupt the labour market through job losses, shifts in skillset demanded, create more employment opportunities and eliminate monotonous and tedious tasks (Brown *et al.,* 2017, Whitehouse, 2016). In the agriculture and food sector, the most popular effect perceived by the graduates, 37%, is that artificial intelligence will make work easier. Similarly, most of the graduates employed in the banking and insurance, 43%, as well as those employed in the public sector and services perceive that the application of artificial intelligence will make work relatively easier.

Twenty-nine percent of the graduates employed in the banking and insurance sector and 27% of the graduates employed in the agriculture and food sector perceive shifts in the skillset demanded in the workplace. In a study conducted by PWC, employees believed that the increased application of artificial intelligence poses a demand on them to update the skillset they possess rather than depending on the employer to provide training to update their skillset (Brown *et al.*, 2017).

Employment loss is mostly perceived by graduates employed in the banking and insurance sector, 30%, and 26% in the agriculture and employment sector. The highest proportion of the graduates who perceive employment gain are employed in the banking and insurance sector, 14% and 10% employed in the agriculture sector. While others believe that artificial intelligence will improve job prospects, others are worried about the risk of losing jobs associated with continuous application of artificial intelligence (Brown *et al.,* 2017). In all the sectors, there will be a positive increase in the prevalence of artificial intelligence with their current jobs in the next decade. In the agriculture and food sector it will increase by 56%, then 28% in the banking and insurance sector and 57%, in the public sector and research. This, therefore, suggests the nature of work is likely to be impacted by artificial intelligence in all sectors.

None of the graduates perceives employment loss from the application of blockchain technology.

On the contrary, the ability of blockchain technology to verify documents implies that there will be less need manual verification hence causing job losses (Schrant, 2018). The most popular perception of how blockchain technology will change the nature of work is that it will result in shifts in the skills demanded on the labour markets. According to Eaton-Cardone (2017), application of blockchain technology will create new roles in encryption and identity protection. Fifty-seven percent of the respondents employed in the banking sector, 43% of respondents employed in the agriculture and food sector and 43% of those employed in the public sector and research hold a similar opinion about how blockchain will change the nature of jobs. Various studies have ascertained that blockchain technology can help solve fraud issues and improve information transparency across all sectors of the economy (Ge *et al.,* 2017; Kamilaris *et al.,* 2018; Cocco *et al.,* 2017; Schwab, 2016). However, the graduates employed in the public sector and research perceive that blockchain will be less prevalent by 14% in the next decade yet they have optimistic views about it. The optimistic view entails having 17% of the graduates indicating that blockchain will result in employment creation while 29% perceiving that it will make work easier. This might also imply that the graduates have an artificial understanding of the concept of 'blockchain technology'.

The most commonly held perception about robotics is that it will replace people in their jobs, thus causing unemployment. In this study, employment loss was perceived by 40% of the graduates in the agriculture and food sector, 57% in the banking and insurance sector and 43% employed in the public sector and research. About 50% of the respondents employed in the agriculture and food sector, 43% in both the banking and insurance sector and the public and research sector all the sectors perceive that robotics will result in the shifts in skills demanded in the workplace. Moreover, the graduates had indicated that robotics would feature more in their current jobs in the next 10 years. The prevalence of robotics in the agriculture and food sector will increase by 40%, 43% in the banking and insurance sector and 15% in the public sector and research. Organisations are always trying to find ways to work with precision, cut down on operational costs, increase productivity and execute new models (Freeman, 2015; Ford 2015). The results presented inTable 5.1, therefore, validate the assertions of the studies that have proved the increased application of robotics across various sectors of the economy.

4.7 Summary of main findings

This chapter provided the main findings of the study that address the objectives of the study. The first three sections address the first objective, which was to estimate the proportion of graduates who are employed and their perceptions of how their degrees contributed to their employability. A large proportion, 92% of the graduates are employed. The agriculture and food sector is the main employer of the respondents as 63% are employed in the sector. Irrespective of the sector of employment, 76% of the graduates are employed on a full-time basis. This can suggest that recent graduates from the University of Pretoria are not struggling much in getting jobs. Most of the jobs are obtained through application to vacant posts as 46% of the respondents indicated so. A fairly large proportion of the graduates, 28%, also stated that they got their first job using their own connections. Hence suggesting that applying to vacant posts and utilising personal connection that one would have established as the more effective ways of securing employment for agricultural economists. This calls for the university placement office to try more to bridge the gap between job seekers and employers by establishing relationships with prospective employers to the benefit of their graduates.

The graduates are confident about their ability to prepare a good project report, carry out statistical analysis, preparing a farm budget and preparing a solid business plan. This is because more than 60% of the graduates perceived themselves as highly proficient in the listed skills. A relatively large proportion of the graduates perceive themselves as possessing below-average skills in computer programming, 44%. Computer programming is rendered as one of the most relevant skills in the fourth industrial era.

Basing on the results, the degree generally prepared the graduates for the labour market and made significant contributions towards their employability. This is evidenced by the low unemployment rate among the surveyed graduates and their high proficiency in the basic skills expected of an agricultural economist. However, the graduates indicated that they have below-average skills in computer programming. Fleming et.al (2018) in a McKinsey report revealed that computer programming skills and advanced IT skills are fundamental in the digital revolution era Since the fourth industrial revolution is coming with rapid changes in the workplace, graduates are needed to learn new things continuously and computer programming skills and advanced IT skills are core to helping them

learn. Therefore, the results call for a need to equip the graduates more with these skills as they prepare for the future workplace.

In this vein, it is important to determine the familiarity of the graduates with common digital concepts to gauge their aptitude to adopt new digital technologies. Furthermore, it is of paramount to capture their perceived impacts about the digital concepts on their current jobs. Both their aptitude for adopting digital technologies and their perceptions of digital technologies is useful in developing a curriculum that can prepare graduates for the future, and that was discussed from the fourth section.

Results from Table 4.4 revealed that neither 'years of experience' nor GPA is significant in explaining familiarity with digital advancements at all levels of significance. This could, however, be attributable to the small sample and short range of the cohort considered. If the level of significance is however disregarded and only the coefficients are considered, the results indicate a negative relationship between experience and familiarity and a small positive relationship between academic performance and familiarity. This implies that graduates with earlier completion dates were less familiar with digital advancements which would, in turn, cause them to be slow adopters to these technologies. This has implications for digital advancement in companies as the more experienced employees are moving into management positions. A way to rectify this is for companies to make themes relating to digitalization part of a personal development plan.

Having established that none of the variables of interest could be used to determine the aptitude to adopt digital technologies, the graduated perceived impacts were analysed. As years succeed, the extent to which big data, automation, artificial intelligence, robotics, blockchain technology and artificial intelligence applications will increase their prevalence in current jobs. All the graduates employed in the agriculture and food sector perceive that artificial intelligence application will feature to a large extent in their current jobs. The most prominent perception about how artificial intelligence will change the nature of work is employment loss. Making work easier is the popularly perceived impact of big data and automation application. The most perceived impact of robotics application is employment loss. The majority of graduates interviewed believed that blockchain technologies would have no impact on jobs. Blockchain technology can change work in ways that have not yet been remarkably experienced. Hence, it is plausible to perceive no impact from its application. A significant proportion of the respondents employed in all sectors perceived that

all the digital revolution concepts would create demands for new skills. This, therefore, calls for a need to have a curriculum that equips them with ubiquitous skills that can help them to remain competitive.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary

The general objective of this study was to consider the extent with which digitalisation has impacted functions typically performed by agricultural economists to guide curriculum revision.

As mentioned in the problem statement, tertiary education is operating in a briskly changing environment, thereby calling for the need to trace the graduates' career paths to inform curriculum review. A sample was drawn from the population of students who graduated from an undergraduate programme in Agricultural Economics in the 2013 to 2017 cohorts. The focus on this recent group of graduates was because the study was built on KaMakhaya (2014), it considered cohorts which were not included in her study. Moreover, more recent cohorts are more likely to have a sound recollection of the degree programme content to relate their perceptions on digitalisation and how their studies have prepared them for it. The first objective, therefore, sought to estimate the proportion of graduates who are employed and their perceptions of how the degree contributed to their employability. A large proportion of the graduates, 82%, are gainfully employed while 8% were not employed. Applying to vacant posts was the common way used by the graduates to get their first job as, 46%, of the graduates, indicated so. The majority of the graduates, 70%, have at least pursued an Honors degree in Agricultural economics. Most of the respondents, 63%, are employed in the agriculture and food sector. Communication skills presented during an interview and academic performance are deemed as the most significant factors contributing to landing one a job. Upon completion of their degree, the graduates were most proficient in preparing a good report and highlighted that they needed improvements in computer programming skills and transacting on SAFEX. Computer programming skills and advanced IT and analytical skills are rendered as very important skills for the fourth industrial revolution labour market.

The second objective of the study set out to determine the familiarity of the graduates with concepts related to general digital advancement. This could serve as a proxy for aptitude to adopt new digital technology. It was expected that their aptitude to accept general advancements would be closely linked to the adoption of digital technology in the workspace. To address the second objective, it

was further hypothesized that there is a negative relationship between the years of work experience a graduate has and the familiarity with digital advancements. A familiarity score was calculated so as to determine the graduates' aptitude to adopt new digital technologies. The lower the familiarity score, the higher the respondent's familiarity with digital technologies and aptitude to accept them. The scores ranged from 13 to 23, and the average score was 17.5 which was more skewed towards the low familiarity. Using familiarity as a proxy for the adoption of new technologies, the results suggested that the graduates are not adept at using new digital technologies hence negatively affecting their adoption.

The third objective set out to identify the key determinants of propensity to adopt new digital technologies by considering specifically years of experience and undergraduate academic performance. To address the third objective, it was hypothesized that there is a positive relationship between the academic performance of a graduate at the undergraduate level and their familiarity with digital advancements. It was further hypothesized that there is a negative relationship between the years of work experience a graduate has and the familiarity with digital advancements. Academic performance and years of experience were regressed on the familiarity so as to test the hypotheses. While there was a positive relationship between academic performance and the graduates' propensity to adopt new digital technologies, familiarity score, it was not statistically significant. This suggested that academic performance was not relevant in explaining graduates' aptitude to adopt new technologies. Years of professional experience are also not a key determinant in determining the graduates' aptitude to adopt new technologies. The null hypothesis was rejected and concluded that the aptitude for adopting new technologies is higher in more experienced graduates. Having found that neither academic performance nor years of professional experience could be used to determine the graduates' aptitude to adopt new technologies, their perceived impacts were considered. The graduates perceive that an increased prevalence of automation, big data, artificial intelligence, robotics and blockchain technologies in their current jobs. The popular impact perceived as a result of the application of robotics and artificial intelligence is employment loss. Big data and automation are commonly perceived to result in making work easier. Application of blockchain technology is perceived as having no impact on the nature of jobs by most of the graduates.

5.2 Conclusion

Based on the findings, this section draws the main conclusions of this study. It further provides a summary of suggestions given by the respondents on the changes that can be incorporated in the current curriculum

According to the graduates' perceptions, the existing curriculum is making significant contributions to the employability of the graduates. It is substantiated by the low unemployment rate among the respondents. Besides, the graduates indicated that communication skills and academic performance were important in their successful job placement. Development of the two attributes is embedded in the existing curriculum. More attention should, however, be given to developing computer programming skills and provide more training on SAFEX. This, therefore, proposes maintaining the current curriculum while making few adjustments in response to prevailing hiring trends in the industry.

Academic performance and years of professional experience could not be considered as determinants of the graduates' propensity to adapt to new technologies. However, the literature reviewed for this study suggests otherwise. The small sample could have contributed to this result. Therefore, the study can be replicated with a larger sample to see if there are any changes.

Irrefutably, most agricultural economists are exposed to digital technologies beget by the digital revolution as shown by the familiarity scores in Figure 4.4 though the mean familiarity score suggested otherwise. However, their perceptions about the impacts of the digital revolution in the workplace are in line with the perceived impacts in literature. The respondents perceived job losses, employment creation, and changes in skillset demanded on the labour market and making tasks easier. To some extent concepts like big data and blockchain technologies are perceived to have no direct impacts on current jobs. On the other hand, the graduates perceived an increased prevalence of automation, big data, artificial intelligence, and robotics and blockchain technology with their current jobs. Their perceived impacts and perceived prevalence of the fourth industrial revolution concepts are misaligned. The misalignment suggests that the graduates have a superficial knowledge of issues related to the fourth industrial revolution. This, therefore, provides a rationale to integrate these concepts into the curriculum. Moreover, some of the course material is becoming less relevant in the digital revolution era. Equipping students with skills such as

regression analysis for market analysis is becoming less applicable as analytical approaches are changing owing to big data. This further suggests that the respondents might have perceived big data and digital acumen as just buzz words hence the need to integrate the concepts in the curriculum.

5.3 Recommendations

Universities and other academic institutions are required to build and sustain a workforce, which is familiar with artificial intelligence and other digital revolution concepts. Financial support should be availed for staff training on the digital revolution, which includes professional development stipends, fellowships and internships. Moreover, courses on software development should be included in curricula and should utilize active case studies to demonstrate the application of digital revolution concepts (Whitehouse, 2016).

While the government is making a significant investment towards providing affordable university education, the government needs to invest more in research and development associated with the digital revolution. This will aid in strengthening the investments they are making in education.

In the 2019 State of Nation Address (SONA), President Cyril Ramaphosa alluded that the government of South Africa is committed to adding new subjects in the primary school curriculum through various programmes. Some of the subjects that will be added include coding and data analytics to prepare the future workforce for future jobs and opportunities (SONA, 2019). Universities, therefore, also need to introduce new modules that align with the fourth industrial revolution skills demands. Given that the University of Pretoria agricultural economics graduates are not struggling much with landing jobs, any addition or elimination of modules should be guided with the existing curriculum provided in appendix B.

REFERENCES

Adelaja, A. O., 2003. The 21st century land grant economist. *Agricultural and Resource Economics Review*, 32, pp.159-170.

Ameen A.A., Ahmad K., 2017. Information Systems Strategies to Reduce Financial Corruption. In: Benlamri R., Sparer M. (eds) *Leadership, Innovation and Entrepreneurship as Driving Forces of the Global Economy*. Springer Proceedings in Business and Economics. Springer, Cham.pp.731-740

African Center for Economic Transformation (ACET), 2016. Unemployment in Africa: No jobs for 50% of graduates. https://acetforafrica.org/highlights/unemployment-in-africa-no-jobs-for-50-of-graduates/

Alphabeta. 2017. The economic impact of geospatial services. How consumers, businesses and society benefit from location-based information. http://www.alphabeta.com/wp-content/uploads/2017/09/GeoSpatial-Report_Sept-2017.pdf

Amakobe, M. A. The Impact of Big Data Analytics on the Banking Industry. https://www.researchgate.net/publication/280446380_The_Impact_of_Big_Data_Analytics_on_the_Banking_Industry

Artz, G. M., Kimle, K. L. & Orazem, P. F., 2013. Does the Jack of all trades hold the winning hand? Comparing the role of specialized versus general skills in the returns to an agricultural degree. *American Journal of Agricultural Economics*, 96**,** pp.193-212.

Axelrad, H., Malul, M. and Luski, I., 2018. Unemployment among younger and older individuals: Does conventional data about unemployment tell us the whole story? *Journal for labour market research*, 52(1), pp.3.

Badiru, E.O. and Wahome, M., 2016. Conducting Graduate Tracer Studies for Quality Assurance in East African Universities: A Focus on Graduate Students Voices on Quality Culture. *Journal of Education and Practice*, *7*(6), pp.174-181.

Bandura, A., 2000. Exercise of human agency through collective efficacy. *Current directions in psychological science*, *9*(3), pp.75-78.

Banwari, V., Fourth Industrial Revolution: Role of Education and Government. *International Journal of -Research in Engineering, IT and Social Sciences*, 8, pp.47-51.

Basir, M.H.B.A., 2016. Relationship between academic performance and skills with employability moderating effect of work experience. Case study from audit firms' perspective in Kota Kinabalu. Masters thesis, Universiti Malaysia Sabah. http://eprints.ums.edu.my/id/eprint/10715

Bennett, N., Dunne, E. and Carré, C., 1999. Patterns of core and generic skill provision in higher education. *Higher education*, *37*(1), pp.71-93.

Berruti, F., Ross, E. and Weinberg, A. 2017. The Transformative Power of Automation in Banking. *McKinsey & Co*.

Bialik, C., 2010. Lights, Camera, Calculator! The New Celebrity Math. Wall Street Journal. https://www.wsj.com/articles/SB10001424052748704479404575088143982459472

Broekhuizen, H., 2016. Graduate unemployment and Higher Education Institutions in South Africa. Working Papers 08/2016, Stellenbosch University, Department of Economics.

Bronson, K. and Knezevic, I., 2016. Big Data in food and agriculture. *Big Data & Society*, 3(1)**,** pp**.**2053951716648174.

Broussard, M., Diakopoulos, N., Guzman, A.L., Abebe, R., Dupagne, M. and Chuan, C.H., 2019. Artificial Intelligence and Journalism. *Journalism & Mass Communication Quarterly*, *96*(3), pp.673-695.

Brown, J., Gosling, T., Sethi, B., Sheppard, B., Stubbings, C., Sviokla, J. and Zarubina, D., 2017. Workforce of the future: The competing forces shaping 2030. *PwC*. https://www.pwc.com/gx/en/services/people-organisation/workforce-of-the-future/workforce-of-the-future-the-competing-forces-shaping-2030-pwc.pdf

Brown, J.S. and Thomas, D., 2011. A new culture of learning. Cultivating the Imagination for a World of Constant Change. Lexington, Ky. CreateSpace

Buchanan, B. 2019. Artificial intelligence in finance. The Alan Truing Institute. http://doi.org/10.5281/zenodo.2612537

Business Insider. 2019. This was the longest Uber trip in South Africa – ever. https://www.businessinsider.co.za/uber-south-africa-longest-trip-most-visited-destinations-johannesburg-cape-town-durban-2019-10

Butler-Adam, J., 2018. The fourth industrial revolution and education. *South African Journal of Science*, *114*(5-6), pp.1-1.

Caetano, L. & Charamba, A. 2017. Implications of the Fourth Industrial Revolution. *HR Future*, 2017**,** pp.26-28.

Carnevale, A.P., Strohl, J. and Melton, M., 2013. What's it Worth? The economic value of college majors. https://cew.georgetown.edu/cew-reports/whats-it-worth-the-economic-value-of-college-majors/#full-report

Carson, B., Romanelli, G., Walsh, P. and Zhumaev, A., 2018. Blockchain beyond the hype: What is the strategic business value. *McKinsey & Company*.

Chakraborty, C. and Joseph, A., 2017. Machine learning at central banks. Bank of England Working Paper No.674. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3031796

Chevalier, A. and Conlon, G., 2003. Does It Pay to Attend a Prestigious University? CEEDP (33). Centre for the Economics of Education, London School of Economics and Political Science, London, UK.

Clement, J. 2019a. Number of Facebook users in South Africa from 2017 to 2023 (millions). Statista report. https://www.statista.com/statistics/558248/number-of-facebook-users-in-south-africa/

Clement, J. 2019b. PayPal's annual payment volume from 2012 to 2018 (in billion U.S. dollars). Statista report. https://www.statista.com/statistics/419783/paypals-annual-payment-

volume/

Cocco, L., Pinna, A. and Marchesi, M., 2017. Banking on blockchain: Costs savings thanks to the blockchain technology. *Future Internet*, 9**,** pp.25.

Comm100. 2019. 21 Essential chatbot statistics for 2019. Optimize your customer experience strategy with these chatbot data points. https://www.comm100.com/engage/chatbot-statistics/

Czaja, S. J. and Lee, C. C., 2007. The impact of aging on access to technology. *Universal Access in the Information Society*, 5**,** pp.341.

Dacre Pool, L. and Sewell, P., 2007. The key to employability: developing a practical model of graduate employability. *Education+ Training*, *49*(4), pp.277-289.

Dai, X., 2018. The digital revolution and governance. Routledge. Subs of International Thomson. New York. United States

Dash, M., Bakshi, S. and Chugh, A., 2017. The Relationship Between Work Experience and Employee Compensation: A Case Study of the Indian IT Industry. *Journal of Applied Management and Investments*, 6**,** pp.5-10.

Deloitte, 2016. Machines with purpose from theory to practice. Artificial intelligence in professional services. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/bps/deloitte-uk-machines-with-purpose-ai-report.pdf

Deloitte, 2018. Blockchain in Public Sector: Transforming government services through exponential technologies. https://www2.deloitte.com/content/dam/Deloitte/in/Documents/public-sector/in-ps-blockchain-noexp.pdf

Distaso, M. W. and Bortree, D. S., 2012. Multi-method analysis of transparency in social media practices: Survey, interviews and content analysis. *Public Relations Review*, 38**,** pp.511-514.

Eaton-Cardone, M. 2017.How blockchain will affect financial services employment. E-financial careers news. https://news.efinancialcareers.com/it-en/269710/how-blockchain-will-affect-financial-services-employment

Eggers, W. D., Schatsky, D. and Viechnicki, P., 2017. AI augmented government: using cognitive technologies to redesign public sector work. *Deloitte Center for Government Insights*.

Enago Academy, 2018. Is Artificial Intelligence Good or Bad for Academic Research? https://www.enago.com/academy/academic-publishing-machine-learning-era/

Escotet, M.E., 2012. What is the purpose of higher education: knowledge or utility? *Retrieved October*, *17*, p.2013. https://miguelescotet.com/2012/what-is-the-purpose-of-higher- education-knowledge-or-utility/

Finch, D. J., Hamilton, L. K., Baldwin, R. and Zehner, M., 2013. An Exploratory Study of Factors Affecting Undergraduate Employability. *Education+ Training*, 55**,** pp. 681-704.

Fleming K.et.al, 2017. The digital future of work: What skills will be needed? McKinsey and Company publication. https://www.mckinsey.com/featured-insights/future-of-work/the-

digital-future-of-work-what-skills-will-be-needed

Fleming, A., Jakku, E., Lim-Camacho, L., Taylor, B. and Thorburn, P., 2018. Is big data for big farming or for everyone? Perceptions in the Australian grains industry. *Agronomy for Sustainable Development.* 38(3), pp.1-10.

Ford, M., 2015. *Rise of the Robots: Technology and the Threat of a Jobless Future*, Basic Books.

Ford, M., 2013. Could artificial intelligence create an unemployment crisis? *Communications of the ACM*, *56*(7), pp.37-39.

Fortino, A., 2014. The purpose of higher education: to create prepared minds. *Paradigm Research International*. https://evolllution.com/opinions/the-purpose-of-higher-education-to-create-prepared-minds/

Freeman, R. B., 2015. Who owns the robots rules the world? *IZA World of Labor*.

Frey, C. B. and Osborne, M. A., 2017. The future of employment: How susceptible are jobs to computerisation? *Technological forecasting and social change*, 114**,** pp.254-280.

Frey, C.B. and Osborne, M., 2013. The future of employment. *Oxford Martin Programme on Technology and Employment.* University of Oxford. http://sep4u.gr/wpcontent/uploads/The_Future_of_Employment_ox_2013.pdf

Fuseini, A., Wotton, S.B., Knowles, T.G. and Hadley, P.J., 2017. Halal meat fraud and safety issues in the UK: a review in the context of the European Union. *Food Ethics*, *1*(2), pp.127-142.

Ge, L., Brewster, C., Spek, J., Smeenk, A., Top, J., Van Diepen, F., Klaase, B., Graumans, C. & De Wildt, M. D. R., 2017. *Blockchain for agriculture and food: Findings from the pilot study*, Wageningen Economic Research.

Ge, L., Brewster, C., Spek, J., Smeenk, A., Top, J., Van Diepen, F., Klaase, B., Graumans, C. & De Wildt, M. D. R. 2017. *Blockchain for agriculture and food: Findings from the pilot study*, Wageningen Economic Research.

Gill, T.G. and Hoppe, U., 2009. The business professional doctorate as an informing channel: A survey and analysis. *International Journal of Doctoral Studies*, *4*(1), pp.27-57.

Harry, T., Chinyamurindi, W.T. and Mjoli, T., 2018. Perceptions of factors that affect employability amongst a sample of final-year students at a rural South African university. *SA Journal of Industrial Psychology*, *44*(1), pp.1-10.

Hawksworth, J., Berriman, R. and Goel, S., 2018. Will robots really steal our jobs? An international analysis of the potential long term impact of automation. *PWC Report*.

Hendriks, S.L., 2017. Twelfth cohort of CMAAE graduates complete a semester at UP. https://www.up.ac.za/agricultural-economics-extension-and-rural-development/news/post_2605342-twelfth-cohort-of-cmaae-graduates-complete-a-semester-at-up

Huberty, M., 2015. Awaiting the second big data revolution: from digital noise to value creation. *Journal of Industry, Competition and Trade*, 15**,** pp.35-47.

Hunter-Adams, J., Battersby, J. and Oni, T., 2018. Fault lines in food system governance exposed: reflections from the listeria outbreak in South Africa. *Cities & Health*, *2*(1), pp.17-21.

Jackson, L. A., Zhao, Y., Kolenic Iii, A., Fitzgerald, H. E., Harold, R. and Von Eye, A., 2008. Race, gender, and information technology use: The new digital divide. *CyberPsychology & Behavior,* 11**,** pp**.** 437-442

Jahanmir, S. F. and Cavadas, J. 2018. Factors affecting late adoption of digital innovations. *Journal of business research,* 88**,** pp.337-343.

Jain, A. and Bhatnagar, V., 2016. Analysis of grievances in the banking sector through big data. *International Journal of Service Science, Management, Engineering, and Technology (IJSSMET),* 7**,** pp**.**21-36.

Kamakhaya, S., 2014. *A review of agricultural economics training at South African universities.* University of Pretoria. https://repository.up.ac.za/handle/2263/46260

Kamilaris, A., Fonts, A. & Prenafeta-Boldύ, F. X., 2018. The Rise of the Blockchain Technology in Agriculture and Food Supply Chain. Trends in Food Science &Technology. 91, pp.640-652

Karatuna, I. and Basol, O., 2017. Job satisfaction of part-time vs full-time workers in Turkey: the effect of income and work status satisfaction. *International Journal of Value Chain Management,* 8**,** 58-72.

Kim, G.-H., Trimi, S. and Chung, J.H., 2014. Big-data applications in the government sector. *Communications of the ACM,* 57**,** pp.78-85.

Kirsten, J. F., 2011. Agricultural economics scholarship in South Africa at the crossroads: is it time for a national institute of food, agricultural and resource economics? *Agrekon,* 50**,** 124-144.

Knight, P.T. and Yorke, M., 2002. Employability through the curriculum. *Tertiary education and management*, *8*(4), pp.261-276.

Kolesnikova,J. Kamasheva, A. and Fakhrutdinova, A., 2015. Higher education demands of the labor market. *Procedia-Social and Behavioral Sciences* 191 :pp 1183-1186.

Kőnig, L.S., Juric, P.M. and Koprivnjak, T., 2016. Graduate Employability: A Gap between Perspectives-the Case of Croatia. *Advances in Economics and Business*, *4*(10), pp.525-538.

Kraak, A., 2010. The collapse of the graduate labour market in South Africa: evidence from recent studies. *Research in Post-Compulsory Education*, *15*(1), pp.81-102.

Law, B. and Watts, A.G., 1977. *Schools, careers, and community: a study of some approaches to careers education in schools*. CIO Publishing for the General Synod Board of Education. Church of England.

Le Sève, M.D., Mason, N. and Nassiry, D., 2018. Delivering blockchain's potential for environmental sustainability. Briefing Note. DOI publications

Lorenz, M., Rüßmann, M., Strack, R., Lueth, K. and Bolle, M., 2015. Man and machine in Industry 4.0: How will technology transform the industrial workforce through 2025. *The*

Boston Consulting Group. Inc.

Lowenberg-DeBoer, J., Huang, I.Y., Grigoriadis, V. and Blackmore, S., 2018. Economics of robots and automation in field crop production. *Precision Agriculture* (2019), pp.1-22.

Machethe, C. 2016. The agricultural Economics discipline in a social transforming South Africa: Status, effects and responses and the future. Powerpoint presentation. Tomlinson lecture. http://www.aeasa.org.za/news/314712/FR-Tomlinson-Lecture-2016.htm

Makridakis, S., 2017. The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*, 90**,** pp. 46-60.

Manning, L., Smith, R. and Soon, J.M., 2016. Developing an organizational typology of criminals in the meat supply chain. *Food Policy*, *59*, pp.44-54.

Manning, T., (2008). The Roles of Agricultural Economics. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 28(3), pp.1-5.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C. Byers, A.H., 2011. Big data: The next frontier for innovation, competition, and productivity. *McKinsey Global Institute Research, Tech. Rep.*

Manyika, J., Chui, M., Miremadi, M., Bughin, J., George, K., Willmott, P. and Dewhurst, M., 2017. A future that works: AI automation employment and productivity. McKinsey Global Institute Research, Tech. Rep. A future that works: AI automation employment and productivity. *McKinsey Global Institute Research, Tech. Rep.*

Marwala, T., 2017. Implications of the fourth industrial age in higher education. ResearchGate Publications.

Mawela, T., Ochara, N. M. and Twinomurinzi, H. 2017. E-government implementation: A reflection on South African municipalities. *South African Computer Journal*, 29, pp.147-171.

Mazareanu, E., 2019a. Monthly number of Uber's active users worldwide from 2016 to 2019 (in millions). Statista report. https://www.statista.com/statistics/833743/us-users-ride-sharing-services/

Mazareanu, E., 2019b Check-in method of airline passengers worldwide from 2015 to 2021. Statista report. https://www.statista.com/statistics/493957/check-in-method-airline-passengers/

Mccalla, A., Castle, E. and Eidman, V. 2010. The AAEA: Ever growing and changing research challenges. *American Journal of Agricultural Economics*, 92**,** pp. 334-355.

Mccowan, T., Reilly, T. and Steven, D., 2014. Can higher education solve Africa's job crisis? Understanding graduate employability in Sub-Saharan Africa. *British Council, Policy brief*.

Meyer, J., 2011. Workforce age and technology adoption in small and medium-sized service firms. *Small Business Economics*, 37**,** pp**.**305-324.

Micklewright, J. and Schnepf, S.V., 2010. How reliable are income data collected with a single question? *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, *173*(2), pp.409-429.

Miller, S., 2014. Collaborative approaches needed to close the big data skills gap. *Journal of Organization design*, 3**,** pp.26-30.

Mncayi, N.P., 2016. *The determinants of employment status of young graduates from a South African University* (Doctoral dissertation). https://repository.nwu.ac.za/handle/10394/17038

Mocanu, C., Zamfir, A.M. and Pirciog, S., 2014. Matching Curricula with Labour Market Needs for Higher Education: State of Art, Obstacles and Facilitating Factors. *Procedia-Social and Behavioral Sciences*, *149*, pp.602-606.

Mohamed, A. A., 2018. Evolution of Agricultural Economics: A Review Article for Economists. *Journal of Economics and Sustainable Development*. Vol 9 (19) www.iiste.org.

Morris, M. G. & Venkatesh, V., 2000. Age differences in technology adoption decisions: Implications for a changing work force. *Personnel psychology*, 53**,** pp.375-403

Munsaka, E., 2018. The use of information sharing systems to address opportunistic behaviour between tomato farmers and brokers in Zambia. Masters Dissertation. University of Pretoria. https://repository.up.ac.za/handle/2263/70445

Murase, H., 2000. Artificial intelligence in agriculture. *Computers and Electronics in Agriculture*. 29(1/2), pp. 178.

Muriithi, P., Horner, D. and Pemberton, L. 2016. Factors contributing to adoption and use of information and communication technologies within research collaborations in Kenya. *Information Technology for Development.* 22**,** pp**.**84-100.

Muzofa, C.V., 2015. Online banking usage amongst South African Consumers: An Empirical study of the impact of current usage on future usage intention .Doctoral dissertation. University of Witwatersrand. https://pdfs.semanticscholar.org/3ad1/a38d91955e612fbbb854ad05ff2278fb5176.pdf

National Treasury.2018. Budget Review. http://www.treasury.gov.za/documents/national%20budget/2018/review/FullBR.pdf

Nulty, D. D., 2008. The adequacy of response rates to online and paper surveys: what can be done? *Assessment & evaluation in higher education*, 33**,** pp.301-314.

Oliveira, P. and von Hippel, E., 2011. Users as service innovators: The case of banking services. *Research policy*, *40*(6), pp.806-818.

Olszewski, A., Panorska, A. and Gillam, S. L. 2017. Training verbal and nonverbal communication interview skills to adolescents. *Communication Disorders Quarterly*, 38**,** pp**.** 206- 218.

Oluwajodu, F., Greyling, L., Blaauw, D. and Kleynhans, E.P., 2015. Graduate unemployment in South Africa: Perspectives from the banking sector. *SA Journal of Human Resource Management*, *13*(1), pp.1-9.

Oyekale, A. S., 2017. Micro econometric modeling in applied economic research: the pains, pitfalls and paradoxes. Inaugural Lecture. North West University. https://repository.nwu.ac.za/handle/10394/28098

Panpatte, D., 2018. Artificial Intelligence in Agriculture: An Emerging Era of Research.

Intuition al Science Conference
https://www.researchgate.net/publication/328555978_Artificial_Intelligence_in_Agriculture_An_Emerging_Era_of_Research

Paypal. 2018. PayPal Cross-border consumer research 2018. PayPal report. PowerPoint. https://www.paypalobjects.com/digitalassets/c/website/marketing/global/shared/global/media-resources/documents/PayPal_Insights_2018_Global_Report.pdf

Pegg, A., Waldock, J., Hendy-Isaac, S. and Lawton, R., 2012. Pedagogy for employability. York, UK: Higher Education Academy. http://oro.open.ac.uk/30792/1/Pedagogy_for_employability_170212_1724.pdf

Peters, G. W. and Panayi, E., 2016. Understanding modern banking ledgers through blockchain technologies: Future of transaction processing and smart contracts on the internet of money. *Banking beyond banks and money.* 2016 pp. 239-278

Peters, M.A., 2017. Technological unemployment: Educating for the fourth industrial revolution. *Journal of Self-Governance and Management Economics*, *5*(1), pp.25-33.

Pitan, O. S., 2016. Towards enhancing university graduate employability in Nigeria. *Journal of Sociology and Social Anthropology*, 7**,** pp. 1-11.

Poppe, K., Wolfert, J., Verdouw, C. &and Renwick, A. 2015. A European perspective on the economics of Big Data. *Farm Policy Journal,* 12**,** pp.11-19.

Prisecaru, P., 2016. Challenges of the fourth industrial revolution. *Knowledge Horizons. Economics,* 8**,** pp.57.

Quinland, O. and Sayed, Y., 2016. Changing what universities teach is a process, not a single event. The Conversation. https://theconversation.com/changing-what-universities-teach-is-a-process-not-a-single-event-59327 938667

Rank, P., 2018. The popularity of Google maps: Trends in Navigation Apps 2018. The manifest survey. https://themanifest.com/app-development/popularity-google-maps-trends-navigation-apps-2018

Ribarics, P., 2016. Big Data and its impact on agriculture. *Ecocycles,* 2**,** pp.33-34.

Riddell, W. C. and Song, X., 2012. The role of education in technology use and adoption: Evidence from the Canadian workplace and employee survey. Discussion Papers. Institute of Labor Economics. 6377.

Robinson, J.S., Garton, B.L. and Vaughn, P.R., 2007. Becoming employable: A look at graduates' and supervisors' perceptions of the skills needed for employability. *NACTA Journal*, *51*(2), pp.19-26.

Ross J., 2019. Students want universities to find jobs for them. Institutions urged to outline more clearly what undergraduates can expect of them. Times Higher Education. https://www.timeshighereducation.com/news/students-want-universities-find-jobs-them

Rotman, D., 2013. How technology is destroying jobs. *Technology Review*, *16*(4), pp.28-35.

Runge, C.F.,2006. Agricultural economics: a brief intellectual history. https://ageconsearch.umn.edu/record/13649

SABC news, 2019. Standard Bank acknowledges mistake in branch closures. http://www.sabcnews.com/sabcnews/standard-bank-to-review-decision-to-close-90-branches/

Schomburg, H,. 2016. Carrying out tracer studies: guide to anticipating and matching skills and jobs: volume 6. DOI: 10.2816/938667

Schrant, T.K. 2018. Will block chain impact jobs? Three things you need to know. Insquisitr. https://www.inquisitr.com/4721900/will-blockchain-impact-jobs-three-things-you-need-to-know/

Schuppan, T., 2009. E-Government in developing countries: Experiences from sub-Saharan Africa. *Government Information Quarterly*, 26**, pp.**118-127.

Schwab, K., 2015. World economic forum. *Global Competitiveness Report (2014-2015) Retrieved http://www3. weforum. org/docs/WEF_GlobalCompetitivenessReport_2014-15. pdf.*

Schwab, K., 2016. The Fourth Industrial Revolution by Klaus Schwab. In *Geneva: World Economic Forum*.

Shah, T., Jani, S. and Priyan, P., 2018. Applications of Blockchain Technology in Banking: A Conceptual Approach. *GH Patel Postgraduate Institute of Business Management***, pp.**12.

Shapshak, T,. 2019. Spotify celebrates 1st anniversary in South Africa after coming "home". Forbes. https://www.forbes.com/sites/tobyshapshak/2019/03/13/spotify-celebrates-first- anniversary-in-south-africa/#550ebe23e770

Sharma, P. and Batra, V., 2016. A study of demographic determinants of online shopping behavior of consumers. *International Education and Research Journal*, *2*(3), pp. 63-65.

Smith, B. A., Hoogenboom, G. and Mcclendon, R. W., 2009. Artificial neural networks for automated year-round temperature prediction. *Computers and Electronics in Agriculture*, 68**,** pp. 52-61.

SONA, 2019. President Cyril Ramaphosa: State of the Nation Address 2019. https://www.gov.za/speeches/2SONA2019

Srinivas, V. and Wadhwani, R., 2018. The value of online banking channels in a mobile-centric world. https://www2.deloitte.com/us/en/insights/industry/financial-services/online-banking-usage-in-mobile-centric-world.html

Statista, 2016. Estimated number of active streaming subscribers to Netflix in South Africa from 2016 to 2020 (in 1,000s). Statista. https://www.statista.com/statistics/607684/south-africa-netflix-subscribers/

StatSA, 2019. Quartely Labour Force Survey. http://www.statssa.gov.za/publications/P0211/P02111stQuarter2019.pdf

StatSA. 2017. Education Series Volume V. Higher Education and skills in South Africa. Report No 92-01-05. http://www.statssa.gov.za/publications/Report-92-01-05/Report-92-01-052017.pdf

Stone, P., Brooks, R., Brynjolfsson, E., Calo, R., Etzioni, O., Hager, G., Hirschberg, J., Kalyanakrishnan, S., Kamar, E. and Kraus, S., 2016. Artificial Intelligence and Life in 2030. One-hundred-year study on artificial intelligence: Report of the 2015-2016 Study Panel. *Stanford University, Stanford, CA, http://ai100. stanford. edu/2016-report. Accessed: September*, 6**,** 2016.

Suleman, F. 2018. The employability skills of higher education graduates: insights into conceptual frameworks and methodological options. *Higher Education***,** 1-16.

Sumanasiri, E.G.T., Yajid, M.S.A. and Khatibi, A., 2015. Review of literature on graduate employability. *Journal of Studies in Education*, *5*(3), pp.75-88.

Teichler, U. 2018. Higher Education and Graduate Employment: Changing Conditions and Opportunities. DOI: 10.17906 / INCHER.0002

Tezer, T., 2018. Examining chatbot usage by country around the world. Chatbots Magazine. https://chatbotsmagazine.com/examining-chatbot-usage-by-country-around-the-world-e114a2ce8692

The South African, 2019. Sasbo's national strike will shut down ATM's and banking services. https://www.thesouthafrican.com/business-finance/sasbos-national-strike-will-shut-down-atms-and-banking-services/

Thijssen, J.G., Van der Heijden, B.I. and Rocco, T.S., 2008. Toward the employability—link model: current employment transition to future employment perspectives. *Human Resource Development Review*, *7*(2), pp.165-183.

Thurairaj, S., Hoon, E.P., Roy, S.S. and Fong, P.W., 2015. Reflections of students' language usage in social networking sites: making or marring academic English. *Electronic Journal of e-Learning*, *13*(4), pp.302-316.

UNESCO, 2010. Trends in tertiary education: Sub-Saharan Africa. *UIS Fact Sheet*.

United Nations Global Plan for the decade of action for road safety, 2011. Global plan for the decade of action for road safety, 2011-2020, version 3. https://www.who.int/roadsafety/decade_of_action/plan/global_plan_decade.pdf

University of Pretoria, 2019. Welcome to our Department. Department of Agricultural Economics, Extension and Rural Development. https://www.up.ac.za/agricultural-economics-extension-and-rural-development/article/46508/welcome-to-our-department

Van der Wal, Z. and Yan, Y., 2018. Could robots do better than our current leaders? World Economic Forum. https://www.weforum.org/agenda/2018/10/could-robot-government-lead-better-current-politicians-ai/

Vander Merwe, M., 2012. Evaluating traceability systems within the South African sheep meat supply chain. Masters Dissertation. University of Pretoria. https://repository.up.ac.za/handle/2263/24959

VanderVyver, B. and Pelster, B., 2017. Take another turn. Careers and Learning. Real time, all the time. Deloitte Publications. https://www2.deloitte.com/global/en/pages/about-deloitte/articles/careers-and-learning-real-time.html

Vedapradha, R. and Ravi, H., 2018. Application of Artificial Intelligence in Investment Banks. *Review of Economic and Business Studies,* 11**,** pp.131-136.

Vink, N., Hendriks, S.L., and Kirsten, J.F., 2011. 50 years of achievement: The Agricultural Economics Association of South Africa The rise of supermarkets in Africa. https://www.researchgate.net/publication/263367398_50_years_of_achievement_The_Agricultural_Economics_Assocaition_of_South_Africa

Ward, D., 2019. New Campaign for car and motorcycle launches in South Africa. AA report. https://www.aa.co.za/insights/new-campaign-for-car-and-motorcycle-safety-launches-in-sa

Watson, A., 2019a. Cumulative time spent listening to Spotify content worldwide from 2015 to 2017 (in billion hours). Statista report. https://www.statista.com/statistics/813804/spotify-content-time-spent-listening/

Watson, A., 2019b. Netflix - Statistics & Facts. Statista report. https://www.statista.com/topics/842/netflix/

We are social. 2018. Global digital report 2017. https://digitalreport.wearesocial.com/

Weinberg, B. A., 2004. Experience and technology adoption. Discussion Paper No. 1051. Institute for the Study of Labor (IZA), Bonn. https://www.econstor.eu/bitstream/10419/20286/1/dp1051.pdf

Wharton, C.Y. and Horrocks, J., 2015. Students' perceptions of employability within their degree programme: Highlighting the disparity between what academics believe is included and the student experience. In the 2nd conference *Enhancement and Innovation in Higher Education*.

Whitehouse. 2016. Artificial intelligence, automation, and the economy. *Executive office of the President. https://obamawhitehouse. archives. gov/sites/whitehouse. gov/files/documents/Artificial-Intelligence-Automation-Economy. PDF*.

Whiting, A. & Williams, D., 2013. Why people use social media: a uses and gratifications approach. *Qualitative Market Research: An International Journal,* 16**,** pp. 362-369.

Wilson, F., Kickul, J. and Marlino, D., 2007. Gender, entrepreneurial self–efficacy, and entrepreneurial career intentions: Implications for entrepreneurship education. *Entrepreneurship theory and practice*, *31*(3), pp.387-406.

World Economic Forum, 2015. Deep Shift. Technology Tipping Points and Societal Impact. http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf

World Economic Forum, 2016, January. The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution. In *Global Challenge Insight Report, World Economic Forum, Geneva*.

Wright, K.B., 2005. Researching Internet-based populations: Advantages and disadvantages

of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of computer-mediated communication*, *10*(3), p. JCMC 1034.

Xu, M., David, J. M. & Kim, S. H., 2018. The fourth industrial revolution: opportunities and challenges. *International journal of financial research,* 9**,** pp**.** 90-95.

Zolides, A., 2017. *Cult of Personalities: The Influence Economy of Digital Culture*. The University of Wisconsin-Madison.

Appendix A: Study Questionnaire

Graduate tracer study

My name is Sikhanyiso Mhaka. I am an MSc. Agricultural Economics student at the University of Pretoria conducting a graduate tracer study as part of my research.In order to inform curriculum revision for the Department of Agricultural Economics at the University of Pretoria, this questionnaire has been developed to gather feedback regarding the skills required by the industry, but lacking in the curriculum. We value your honest and detailed responses. The questionnaire should take approximately 15 minutes to complete. Your responses are completely anonymous. For any queries you can contact me on +27619875719.

1. **Email address** *

_____

Section 2 : Educational

2. **2.4 Did you take any further studies after your first degree?**
Mark only one oval.

- ◯ Yes
- ◯ No *After the last question in this section, skip to question 3.*

3. **2.5 What were your reasons for taking further studies?**
Mark only one oval.

- ◯ Required by employer
- ◯ Own career development
- ◯ Unemployed and trying to fill up time
- ◯ Not applicable
- ◯ Other: _____

Section 3: Employment

4. **3.2 What is your current employment status?**
Mark only one oval.

- ◯ Employed
- ◯ Unemployed
- ◯ Full-time scholar
- ◯ Self-employed
- ◯ Other: _____

5. **3.3 How did you get your first job after graduation?**
Mark only one oval.

- ◯ Application to a vacant post
- ◯ Employment agency
- ◯ University's placement office
- ◯ University's teaching staff
- ◯ Employers' campus visit
- ◯ Joining family enterprise
- ◯ Personal connection/ contacts
- ◯ Self-employed
- ◯ I am working for the same employer as I did before my studies
- ◯ Not applicable

6. **3.4 In your opinion how important were the following factors in terms of landing your job?**
Mark only one oval per row.

	Very important	Important	Average	Less important
Academic perfomance	◯	◯	◯	◯
Communication skills presented in the interview	◯	◯	◯	◯
Reputation of university	◯	◯	◯	◯
Reputation of the department	◯	◯	◯	◯
Previous work experience	◯	◯	◯	◯

7. **3.5 How many jobs have you had after completion of studies?**

_____

8. **3.6 In which economic sector are you currently employed?**
Mark only one oval.

- ◯ Agriculture, Mining, Fishing and Forestry
- ◯ Manufacturing, Engineering and Construction
- ◯ Research and Consulting
- ◯ Government and its services
- ◯ Banking and Insuarance
- ◯ Other: _____

9. **3.7 How are you employed?**
Mark only one oval.

- ◯ Full-time permanent
- ◯ Full-time contract
- ◯ Part-time permanent
- ◯ Part-time contract
- ◯ Self-employed
- ◯ Not applicable

10. **3.8 Which firm/company are you working for?**

_____

11. **3.9 What is your annual gross salary?**
Mark only one oval.

- ◯ R200 000 or less
- ◯ R201 000- R300 000
- ◯ R301 000- R400 000
- ◯ R401 000-R500 000
- ◯ R501-R600 000
- ◯ More than R600 000
- ◯ Not applicable

12. **3.10 In your opinion how proficient are you in the following?**
Mark only one oval per row.

	Excellent	Above average	Average	Below average	Poor
Prepare farm and enterprise budget on excel	◯	◯	◯	◯	◯
Prepare a solid business plan	◯	◯	◯	◯	◯
Statistical analysis and data management	◯	◯	◯	◯	◯
Be able to transact on SAFEX	◯	◯	◯	◯	◯
Social media usage	◯	◯	◯	◯	◯
Prepare a good project report	◯	◯	◯	◯	◯
Computer programming	◯	◯	◯	◯	◯

Section 4: Agricultural Economics and the digital revolution

The digital revolution refers to the widespread use of telecommunication and computer technology. It includes the use of system that can learn and develop completely by itself. If left unattended to, it could develop infinitely without any human input or guidance. Responses from this section will assist in establishing what needs to be updated in the curriculum so as to prepare graduates for the changes that the digital revolution might bring in the workplace.

13. **4.1 How well do you know the following products and developments?**
Mark only one oval per row.

	I've never heard of it	I've heard of it	I know someone who uses it	I own it/ use it
Google maps	◯	◯	◯	◯
Facebook	◯	◯	◯	◯
Spotify	◯	◯	◯	◯
Online shopping platforms(e.g Amazon, Takealot,Spree)	◯	◯	◯	◯
Paypal	◯	◯	◯	◯
Uber	◯	◯	◯	◯
Online banking/app	◯	◯	◯	◯
Online check-in when flying	◯	◯	◯	◯
Netflix	◯	◯	◯	◯
Online Assistants (Chatbots, SIRI, Alexa)	◯	◯	◯	◯
Automatic car brakes	◯	◯	◯	◯

Section 5: Future of Digital Revolution

14. **5.1 To what extent do you feel these concepts will feature in your current job in the next year?**
Mark only one oval per row.

	Large extent	Some extent	Less to No extent at all
Robotics (e.g technology which assist human beings in manufacturing)			
Big data (complex and real time data sets from sources like social media platforms, collecting customer transactions using smart shopper cards)			
Automation (e.g digital signatures, customer support chat bots, streamlining face to face meetings)			
Artificial Intelligence (e.g smart reply on Gmail, GPS navigation, SIRI, automatic application of car breaks)			
Block chain technology (e.g use of Bitcoin or Cryptocurrency)			

15. **5.2 To what extent do you feel these concepts will feature in your current job in the next 5 years?**
Mark only one oval per row.

	Large extent	Some extent	Less to No extent at all
Robotics (e.g technology which assist human beings in manufacturing)			
Big data (complex and real time data sets from sources like social media platforms, collecting customer transactions using smart shopper cards)			
Automation (e.g digital signatures, customer support chat bots, streamlining face to face meetings)			
Artificial Intelligence (e.g smart reply on Gmail, GPS navigation, SIRI, automatic application of car brakes)			
Block chain technology (e.g use of Bitcoin or Cryptocurrency)			

16. **5.3 To what extent do you feel these concepts will feature in your current job in the next 10 years?**
Mark only one oval per row.

	Large extent	Some extent	Less to No extent at all
Robotics (e.g technology which assist human beings in manufacturing)			
Big data (complex and real time data sets from sources like social media platforms, collecting customer transactions using smart shopper cards)			
Automation (e.g digital signatures, customer support chat bots, streamlining face to face meetings)			
Artificial Intelligence (e.g smart reply on Gmail, GPS navigation, SIRI, automatic application of car brakes)			
Block chain technology (e.g use of Bitcoin or Cryptocurrency)			

Section 6: Preparation for the future

17. **6.2 How do you see the digital revolution concepts changing the nature of work?**
Mark only one oval per row.

	Employment gain	Employment loss	Creating demand for new skills	Making work easier	No impact
Robotics					
Big data					
Automation					
Artificial Intelligence					
Block chain technology					

18. **6.3 Please provide suggestions on how best digital revolution concepts can be incorporated in the curriculum.**

Appendix B: Undergraduate Curriculum

Degree Programme	Module title	Module Content
First Year		
BSc Agric Agricultural Economics and Agribusiness Management	Agricultural economics 310	Historical evolution of South African agricultural policy. Agriculture and the state: reasons for government intervention. Theoretical aspects of agricultural policy. Introduction to agricultural policy analysis. Welfare principles, pareto optimality. Macroeconomic policy and the Agricultural sector. International agricultural trade.
	Academic information management 111	Find, evaluate, process, manage and present information resources for academic purposes using appropriate technology.
	Academic information management 121	Apply effective search strategies in different technological environments. Demonstrate the ethical and fair use of information resources. Integrate 21st-century communications into the management of academic information.
	Language and study skills 110	The module aims to equip students with the ability to cope with the reading and writing demands of scientific disciplines.
	Academic information management 102	Find, evaluate, process, manage and present information resources for academic purposes using appropriate technology. Apply effective search strategies in different technological environments. Demonstrate the ethical and fair use of information resources. Integrate 21st-century communications into the management of academic information.
	Plant biology 161	Basic plant structure and function; introductory plant taxonomy and plant systematics; principles of plant molecular biology and biotechnology; adaptation of plants to stress; medicinal compounds from plants; basic principles of plant ecology and their application in natural resource management.
	General chemistry 117	General introduction to inorganic, analytical and physical chemistry. Atomic structure and periodicity. Molecular structure and chemical bonding using the VSEOR model. Nomenclature of inorganic ions and compounds. Classification of reactions: precipitation, acid-base, redox reactions and gas-forming reactions. Mole concept and stoichiometric calculations concerning chemical formulas and chemical reactions. Principles of reactivity: energy and chemical reactions. Physical behaviour gases, liquids, solids and solutions and the role of intermolecular forces. Rate of reactions: Introduction to chemical kinetics.
	General chemistry 127	Theory: General physical-analytical chemistry: Chemical equilibrium, acids and bases, buffers, solubility equilibrium,

		entropy and free energy, electrochemistry. Organic chemistry: Structure (bonding), nomenclature, isomerism, introductory stereochemistry, introduction to chemical reactions and chemical properties of organic compounds and biological compounds, i.e. carbohydrates and amino acids. Practical: Molecular structure (model building), synthesis and properties of simple organic compounds.
	Financial accounting 111	The nature and function of accounting; the development of accounting; financial position; financial result; the recording process; processing of accounting data; treatment of VAT; elementary income statement and balance sheet; flow of documents; accounting systems; introduction to internal control and internal control measures; bank reconciliations; control accounts; adjustments; financial statements of a sole proprietorship; the accounting framework.
	Financial accounting 121	Property, plant and equipment; intangible assets; inventories; liabilities; presentation of financial statements; enterprises without profit motive; partnerships; companies; close corporations; cash flow statements; analysis and interpretation of financial statements.
	Introductory genetics 161	Chromosomes and cell division. Principles of Mendelian inheritance: locus and alleles, dominance interactions and epistasis. Probability studies. Sex determination and sex linked traits. Pedigree analysis. Extra nuclear inheritance. Genetic linkage and chromosome mapping. Chromosome variation.
	Molecular and cell biology 111	Introductory study of the ultra-structure, function and composition of representative cells and cell components. General principles of cell metabolism, molecular genetics, cell growth, cell division and differentiation.
	Mathematics 134	Functions, derivatives, interpretation of the derivative, rules of differentiation, applications of differentiation, integration, interpretation of the definite integral, applications of integration. Matrices, solutions of systems of equations. All topics are studied in the context of applications.
	Animal diversity 161	Animal classification, phylogeny, organization and terminology. Evolution of the various animal phyla, morphological characteristics and life cycles of parasitic and non-parasitic animals. Structure and function of reproductive, respiratory, excretory, circulatory and digestive systems.
Second Year		
	Economics 110	This module deals with the core principles of economics. A distinction between macroeconomics and microeconomics is made. A discussion of the market system and circular flow of goods, services and money is followed by a section dealing with microeconomic principles, including demand and supply analysis, consumer behaviour and utility maximisation, production and the costs thereof, and the

		different market models and firm behaviour. Labour market institutions and issues, wage determination, as well as income inequality and poverty, are also addressed. A section of money, banking, interest rates and monetary policy concludes the course.
	Economics 120	This module deals with the core principles of economics, especially macroeconomic measurement the private and public sectors of the South African economy receive attention, while basic macroeconomic relationships and the measurement of domestic output and national income are discussed. Aggregate demand and supply analysis stands core to this course which is also used to introduce students to the analysis of economic growth, unemployment and inflation. The microeconomics of government is addressed in a separate section, followed by a section on international economics, focusing on international trade, exchange rates and the balance of payments. The economics of developing countries and South Africa in the global economy conclude the course.
	Introduction to food science and technology 250	Food Science as a discipline. Activities of Food Scientists and Nutritionists. How food is produced, processed and distributed (food pipeline). World food problem. Human nutrition and human food requirements. Constituents of foods: Functional properties. Food quality. Food deterioration and control (food preservation). Unit operations in food processing. Food safety, risks and hazards. Principles of food packaging. Food legislation and labelling. Food processing and the environment. Practicals: Group assignments applying the theory in practice; practical demonstrations in pilot plants; guest lecturers on the world of food scientists and nutritionists; factory visit/videos of food processing.
	Introductory soil science 250	Origin and development of soil, weathering and soil formation processes. Profile differentiation and morphology. Physical characteristics: texture, structure, soil water, atmosphere and temperature. Chemical characteristics: clay minerals, ion exchange, pH, buffer action, soil acidification and sanitation of soil. Soil fertility and fertilisation. Soil classification. Practical work: Laboratory evaluation of simple soil characteristics. Field practicals on soil formation in the Pretoria area.
	Introduction to agricultural economics 210	Introduction to financial management in agriculture: Farm management and agricultural finance, farm management information; analysis and interpretation of farm financial statements; risk and farm planning. Budgets: partial, break-even, enterprise, total, cash flow and capital budgets. Time value of money. Introduction to production and resource use: the agricultural production function, total physical product curve, marginal physical product curve, average physical product curve, stages of production. Assessing short-term

		business costs; Economics of short-term decisions. Economics of input substitution: Least-cost use of inputs for a given output, short-term least-cost input use, effects of input price changes. Least-cost input use for a given budget. Economics of product substitution. Product combinations for maximum profit. Economics of crop and animal production.
	Agricultural Economics 220	The agribusiness system; the unique characteristics of agricultural products; marketing functions and costs; market structure; historical evolution of agricultural marketing in South Africa. Marketing environment and price analysis in agriculture: Introduction to supply and demand analysis. Marketing plan and strategies for agricultural commodities; market analysis; product management; distribution channels for agricultural commodities, the agricultural supply chain, the agricultural futures market.
	Sustainable crop production and agro climatology 251	Influence of climate on cropping systems in South Africa. The surface energy balance. Hydrological cycles and the soil water balance. Sustainable crop production. Simple radiation and water-limited models. Potential yield, target yield and maximum economic yield. Crop nutrition and fertilizer management. Principles of soil cultivation and conservation. Climate change and crop production – mitigation and adaptation.
	Statistics 110	Descriptive statistics: Sampling and the collection of data; frequency distributions and graphical representations. Descriptive measures of location and dispersion. Probability and inference: Introductory probability theory and theoretical distributions. Sampling distributions. Estimation theory and hypothesis testing of sampling averages and proportions (one and two-sample cases). Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.
	Statistics 120	Multivariate statistics: Analysis of variance, categorical data analysis, distribution-free methods, curve fitting, regression and correlation, the analysis of time series and indices. Statistical and economical applications of quantitative techniques: Systems of linear equations: drafting, matrices, solving and application. Optimisation; linear functions (two and more independent variables), non-linear functions (one and two independent variables). Marginal and total functions. Stochastic and deterministic variables in a statistical and economic context: producers' and consumers' surplus, distribution functions, probability distributions, probability density functions. Identification, use, evaluation, interpretation of statistical computer packages and statistical techniques.

	Animal Science 250	A brief perspective on the South African livestock industry. South African biomes in which animal production is practised. Animal ecological factors that influence regional classification. Introduction to adaptation physiology with reference to origin and domestication of farm and companion animals. Livestock species, breed development and breed characterisation. Basic principles of animal breeding and genetics, animal nutrition. Practical work includes the identification and classification of different breeds of livestock.
	Animal Science 260	Introduction to the concepts of animal production systems in South African production environments. Principles and requirements for extensive, semi-intensive and intensive livestock production with reference to large- and small stock, poultry and pigs. Principles of communal farming systems in Southern Africa. Game management systems with reference to conservation and game farming. The role of the human in livestock production systems and sustainable production.
Third Year		
	Communication 421	Communication: Definition and clarification of concepts. Theory and elements of communication. Verbal and non-verbal communication. Determinants of interpersonal communication. Abating factors impeding communication. Nature, classification and efficiency of communication channels.
	Business law 210	Basic principles of the law of contract. Law of sales, credit agreements, lease.
	Economics 224	Microeconomic insight is provided into consumer and producer theory, general microeconomic equilibrium, Pareto-optimality and optimality of the price mechanism, welfare economics, market forms and the production structure of South Africa. Statistic and econometric analysis of microeconomic issues.
	Principles and practices 351	The organised nursery industry in South Africa. Principles: seed production; seed germination; rooting of cuttings; budding and grafting; propagation using specialised organs; micropropagation (tissue culturing). Practices: Greenhouse construction, lighting in the nursery; cooling and heating; soil-based and soil-less growing media; container types; irrigation and fertilisation; growth manipulation; pest and disease management. Management, economic and marketing aspects of a typical nursery operation. Students will get hands-on experience and will visit nurseries.
	Statistics 210	Counting techniques. Probability theory: Sample spaces, events, and rules of probability, conditional probabilities, independent events and Bayes' theorem. Probability distributions and probability densities: cumulative distribution functions, marginal distributions, joint distributions, conditional distributions and independence. Expected values: Moments, Chebyshev's theorem, moment-

		generating functions, product moments, moments of linear combinations of random variables and conditional expectations. Transformation techniques of random variables. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.
	Statistics 220	Special probability distributions: the discrete uniform distribution, Bernoulli distribution, binomial distribution, negative binomial and geometric distribution, the hypergeometric distribution, Poisson distribution and multinomial distribution. Special probability densities: Uniform distribution, gamma, exponential and chi-square distributions, the beta distribution, the normal distribution and the bivariate normal distribution. Functions of random variables. Sampling distributions, point estimation, interval estimation and hypothesis testing. Regression Analysis. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.
	Economics 244	From general equilibrium and economic welfare to uncertainty and asymmetric information. In this module, we apply the principles learned in EKN 224 on the world around us by looking at the microeconomic principles of labour and capital markets, as well as reasons why the free market system could fail. We touch on the government's role in market failures. The course includes topics of the mathematical and econometric analysis of microeconomic issues.
	Field crops 361	Botanical characteristics, classification, growth requirements, production practices and utilization of crops rich in starch, oil and protein, fibre crops, tobacco, sugarcane and medicinal plants. Visits to research institutions and producers.
	Soil-water relationship and irrigation 350	Quantitative description and measurement of soil water content and potential as well as saturated and unsaturated hydraulic conductivity. Modelling water flow in soil (Darcy's law, Richards's equation). Infiltration, redistribution, evaporation, runoff and percolation. Irrigation in South Africa. Modelling and managing the soil water balance. Plant water consumption and the soil-plant- atmosphere continuum. Irrigation scheduling (soil, plant and atmosphere approaches). Managing poor quality water. Irrigation systems. The module includes a field trip to an irrigation scheme.
	Statistics 310	Regression analysis: simple and multiple regression; nonlinear regression; correlation and the use of dummy variables. Multivariate distributions: normal, multinomial and poisson distribution. Linear combinations of normal variables. Analysis of variance and covariance. Categorical data analysis. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.

	Statistics 320	Regression analysis extensions: heteroscedasticity, serial correlation and lag structures. Time-series analysis. Applications of matrices, differentiation and integration in the economic and management sciences. Evaluation of simple economic models. Theory and applications of time-series models: univariate time series. Stationary and non-stationary time series. ARMA and ARIMA models. Regression models. Model identification and estimation. Spectrum and periodogram. Forecasting with time-series models. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques. Student seminars.
	Planted pastures and fodder crops 320	The establishment and use of planted pastures species and fodder crops and the conservation of fodder. This will enable students to advise users on the establishment and utilization of planted pastures species as well as farmers on the production, conservation and optimum use of fodder. This will also form a basis for further research on planted pastures.
	Agricultural economics 320	The modern food and agribusiness system. Key drivers in the global context. Whole farm planning and budget development The financial analysis of farm financial, financial modelling, the financing decision: capital acquisition, creditworthiness, different capital sources, capital structures. The investment decision and working capital management. Value chains in agribusiness. Risk management. Strategic management and marketing principles in agribusiness. Operational management and human resources management. Business planning for agribusiness.
Fourth Year		
	Agricultural economics 415	Derivative instruments in agriculture: To prepare students for taking the SAFEX Agricultural Markets Division brokerage exam. Giving an in-depth knowledge on the importance of hedging. Giving an in-depth knowledge on designing and implementation of low/zero risk hedging strategies. Introduction to the mathematics of portfolio management and mathematical modelling of derivatives. Working knowledge of the mathematical relationships in the management of a hedged portfolio. Working knowledge of the applicable software for managing derivative portfolios. Introduction into the management of option portfolios. To expand the thinking on the uses of derivatives, by also dealing with the hedging of diesel cost, interest rates and weather events.
	Agricultural market and price analysis 410	This module will focus on the fundamentals of demand, supply and agricultural price analysis. After providing an appropriate background in the theoretical concepts of demand and supply, these basics will be applied in the generation of econometric simulation models. This will include the identification of supply and demand shifters as

		well as the elasticities, flexibilities, and impact multipliers. Practical experience in the formulation of these models will be attained from practical sessions. The student will submit a project in which he/she must analyse the demand or supply patterns of a commodity of his/her choice by generating an econometric model. Agricultural price analysis: price determination under different market structures followed by practical sessions on measuring market structures in various ways. This will include the calculation of market concentration. Price trend analysis and measurement of price changes by using indexes, and especially seasonal indexing. All of this will be supported by the relevant practical sessions.
	Agricultural Economics 421	Price and production function analysis. Input-output, input - input and product -product relationships; profit maximization; the production process through time, economies of size; decision making in agriculture under risk and uncertain circumstances; linear programming.
	Introduction to resource economics 424	This module reviews the origins and evolution of natural and environmental resource economics and its main present-day paradigms. Sources of externalities and causes of environmental degradation are examined. An introduction to the concepts and methods backing the design and implementation of environmental policies are provided. Economic valuation of natural and environmental resources is introduced.
	Agriculture and rural development studies 480	Overview of the concepts and theories of rural development; the role of agriculture in rural development. Rural livelihood systems: household farming systems; decisions and the operation of farming systems; non-farm enterprises and SMMEs in the rural economy; household food security. Rural institutions: definitions and role of institutions; land tenure; rural financial markets; local institutional development; human capital, knowledge systems. Methodologies for rural development: the farming systems approach; participatory techniques; assessment of land use patterns (zoning techniques); typology techniques; technology transfer and decision-making support; communication for rural development; planning rural development at the local level.
	Economics 314	International economic insight is provided into international economic relations and history, theory of international trade, international capital movements, international trade politics, economic and customs unions and other forms of regional cooperation and integration, international monetary relations, foreign exchange markets, exchange rate issues and the balance of payments, as well as open economy macroeconomic issues.
	Agricultural market and	This module will focus on the fundamentals of demand, supply and agricultural price analysis. After providing an

	price analysis 410	appropriate background in the theoretical concepts of demand and supply, these basics will be applied in the generation of econometric simulation models. This will include the identification of supply and demand shifters as well as the elasticities, flexibilities, and impact multipliers. Practical experience in the formulation of these models will be attained from practical sessions. The student will submit a project in which he/she must analyse the demand or supply patterns of a commodity of his/her choice by generating an econometric model. Agricultural price analysis: price determination under different market structures followed by practical sessions on measuring market structures in various ways. This will include the calculation of market concentration. Price trend analysis and measurement of price changes by using indexes, and especially seasonal indexing. All of this will be supported by the relevant practical sessions.
	Economics 325	The course provides an introduction to growth economics and also to some topics on development economics. Firstly, historical evidence is covered, and then the canonical Solow growth model and some of its empirical applications (human capital and convergence). Secondly, the new growth theory (the AK and the Romer models of endogenous growth) are covered. Some of the development topics to be covered include technology transfer, social infrastructure and natural resources.
	Statistics 310	Regression analysis: simple and multiple regression; nonlinear regression; correlation and the use of dummy variables. Multivariate distributions: normal, multinomial and poisson distribution. Linear combinations of normal variables. Analysis of variance and covariance. Categorical data analysis. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.
	Statistics 320	Regression analysis extensions: heteroscedasticity, serial correlation and lag structures. Time-series analysis. Applications of matrices, differentiation and integration in the economic and management sciences. Evaluation of simple economic models. Theory and applications of time-series models: univariate time series. Stationary and non-stationary time series. ARMA and ARIMA models. Regression models. Model identification and estimation. Spectrum and periodogram. Forecasting with time-series models. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques. Student seminars.
	The science of data analytics 353	Sampling: basic techniques in probability, non-probability, and sampling methods. Designing experiments: experimental and control groups, different data types and relationships.

		Big and small data: exploring popular trends used in practice. Consultation practises ethical considerations, study design, data collection and presentation, report writing and presentation. Hands-on application of statistical software and packages to real-life datasets.
	Planted pastures and fodder crops 320	The establishment and use of planted pastures species and fodder crops and the conservation of fodder. This will enable students to advise users on the establishment and utilization of planted pastures species as well as farmers on the production, conservation and optimum use of fodder. This will also form a basis for further research on planted pastures.
	Environmental resource assessment and management 450	Determining the resource potential of land on the basis of botanical composition, vegetation cover, animal grazing and browsing potential, water quality, soil quality, chemical, physical and biological soil degradation, soil erosion and other important environmental processes etc. which are essential for integrated agricultural land-use practices. Evaluation of grasses and other vegetation types in terms of environmental adaptation, acceptability and adaptability to a sustainable utilization system and the management requirements of an integrated and adaptive management system.
	Wildlife science 420	Introductory aspects of wildlife conservation, habitat management, wildlife nutrition, and keeping wildlife in zoological gardens.
	Vegetable crops 410	Integration of agronomic, pedological, botanical, economic and management considerations in crop production systems with a view to sustainable maximum economic yield. Case studies of specific crops
First Year		
BCom Agribusiness Management	Academic literacy for Economic and Management Sciences 124	This module intends to equip students with the competence in reading and writing required in the four high impact modules: Business Management, Financial Accounting, Statistics and Economics. Students will also be equipped to interpret and draw **Figure**s and graphs and to do computations and manage relevant formulas. During Semester 1 students engage with the online computer program MyFoundationsLab individually in a flexible learning environment, and during Semester 2, they attend the scheduled contact sessions and do the coursework.
	Academic information management 101	Find, evaluate, process, manage and present information resources for academic purposes using appropriate technology. Apply effective search strategies in different technological environments. Demonstrate the ethical and fair use of information resources. Integrate 21st-century communications into the management of academic information.

	Introduction to Agricultural Economics 210	Introduction to financial management in agriculture: Farm management and agricultural finance, farm management information; analysis and interpretation of farm financial statements; risk and farm planning. Budgets: partial, break-even, enterprise, total, cash flow and capital budgets. Time value of money. Introduction to production and resource use: the agricultural production function, total physical product curve, marginal physical product curve, average physical product curve, stages of production. Assessing short-term business costs; Economics of short-term decisions. Economics of input substitution: Least-cost use of inputs for a given output, short-term least-cost input use, effects of input price changes. Least-cost input use for a given budget. Economics of product substitution. Product combinations for maximum profit. Economics of crop and animal production.
	Marketing Management 120	This module provides an overview of the fundamentals of marketing by considering the exchange process, customer value, marketing research and the development of a marketing plan. It also addresses the marketing mix elements with a specific focus on the seven service marketing elements namely the service product, physical evidence, people, process, distribution, pricing and integrated marketing communication.
	Financial accounting 111	The nature and function of accounting; the development of accounting; financial position; financial result; the recording process; processing of accounting data; treatment of VAT; elementary income statement and balance sheet; flow of documents; accounting systems; introduction to internal control and internal control measures; bank reconciliations; control accounts; adjustments; financial statements of a sole proprietorship; the accounting framework.
	Economics 110	This module deals with the core principles of economics. A distinction between macroeconomics and microeconomics is made. A discussion of the market system and circular flow of goods, services and money is followed by a section dealing with microeconomic principles, including demand and supply analysis, consumer behaviour and utility maximisation, production and the costs thereof, and the different market models and firm behaviour. Labour market institutions and issues, wage determination, as well as income inequality and poverty, are also addressed. A section of money, banking, interest rates and monetary policy concludes the course.
	Economics 120	This module deals with the core principles of economics, especially macroeconomic measurement the private and public sectors of the South African economy receive attention, while basic macroeconomic relationships and the measurement of domestic output and national income are

		discussed. Aggregate demand and supply analysis stands core to this course which is also used to introduce students to the analysis of economic growth, unemployment and inflation. The microeconomics of government is addressed in a separate section, followed by a section on international economics, focusing on international trade, exchange rates and the balance of payments. The economics of developing countries and South Africa in the global economy conclude the course.
	Business management 114	Introduction to business management as a science; the environment in which the enterprise operates; the field of business, the mission and goals of an enterprise; management and entrepreneurship. Responsible leadership and the role of business in society. The choice of a form of the enterprise; the choice of products and/or services; profit and cost planning for different sizes of operating units; the choice of location; the nature of production processes and the layout of the plant or operating unit. Introduction to and overview of general management, especially regarding the five management tasks: strategic management; contemporary developments and management issues; financial management; marketing and public relations. Introduction to and overview of the value chain model; management of the input; management of the purchasing function; management of the transformation process with specific reference to production and operations management; human resources management and information management; corporate governance and black economic empowerment (BEE).
	Business management 124	The nature and development of entrepreneurship; the individual entrepreneur and characteristics of South African entrepreneurs. Creativity and innovation, opportunity finding and exploitation. The business plan and resource requirements are explored. Getting started (business startup). Exploring different routes to entrepreneurship: entering a family business, buying a franchise, home-based business and the business buyout. This semester also covers how entrepreneurs can network and find support in their environments. Case studies of successful entrepreneurs - also South African entrepreneurs - are studied.
	Statistics 110	Descriptive statistics: Sampling and the collection of data; frequency distributions and graphical representations. Descriptive measures of location and dispersion. Probability and inference: Introductory probability theory and theoretical distributions. Sampling distributions. Estimation theory and hypothesis testing of sampling averages and proportions (one and two-sample cases). Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.

	Statistics 120	Analysis of variance, categorical data analysis, distribution-free methods, curve fitting, regression and correlation, the analysis of time series and indices. Statistical and economical applications of quantitative techniques: Systems of linear equations: drafting, matrices, solving and application. Optimisation; linear functions (two and more independent variables), non-linear functions (one and two independent variables). Marginal and total functions. Stochastic and deterministic variables in a statistical and economic context: producers' and consumers' surplus, distribution functions, probability distributions, probability density functions. Identification, use, evaluation, interpretation of statistical computer packages and statistical techniques. This module is also presented as an anti-semester bilingual module.
	Financial accounting 122	Budgeting, payroll accounting, taxation – income tax and an introduction to other types of taxes, credit and the new Credit Act, insurance, accounting for inventories (focus on inventory and the accounting entries, not calculations), interpretation of financial statements.
Second Year		
	Business law 210	Basic principles of the law of contract. Law of sales, credit agreements, lease.
	Business law 220	Labour law. Aspects of security law. Law of insolvency. Entrepreneurial law; company law, the law concerning close corporations. Law of partnerships.
	Economics 214	From Wall and Bay Street to Diagonal Street: a thorough understanding of the mechanisms and theories explaining the workings of the economy is essential. Macroeconomic insight is provided on the real market, the money market, two market equilibrium, monetarism, growth theory, cyclical analysis, inflation, Keynesian general equilibrium analysis and fiscal and monetary policy issues.
	Introduction to agricultural economics 210	Introduction to financial management in agriculture: Farm management and agricultural finance, farm management information; analysis and interpretation of farm financial statements; risk and farm planning. Budgets: partial, break-even, enterprise, total, cash flow and capital budgets. Time value of money. Introduction to production and resource use: the agricultural production function, total physical product curve, marginal physical product curve, average physical product curve, stages of production. Assessing short-term business costs; Economics of short-term decisions. Economics of input substitution: Least-cost use of inputs for a given output, short-term least-cost input use, effects of input price changes. Least-cost input use for a given budget. Economics of product substitution. Product

		combinations for maximum profit. Economics of crop and animal production.
	Agricultural economics 220	The agribusiness system; the unique characteristics of agricultural products; marketing functions and costs; market structure; historical evolution of agricultural marketing in South Africa. Marketing environment and price analysis in agriculture: Introduction to supply and demand analysis. Marketing plan and strategies for agricultural commodities; market analysis; product management; distribution channels for agricultural commodities, the agricultural supply chain, the agricultural futures market.
	Business management 210	The role of logistics in an enterprise; definition and scope of customer service; electronic and other logistics information systems; inventory management; materials management with special reference to Japanese systems; management of the supply chain. Methods of transport and transport costs; types and costs of warehousing; electronic aids in materials handling; cost and price determination of purchases; organising for logistics management; methods for improving logistics performance.
	Business management 220	Project management concepts; needs identification; the project, the project manager and the project team; types of project organisations; project communication and documentation. Planning and control: planning, scheduling and schedule control of projects; resource considerations and allocations; cost planning and performance evaluation.
	Statistics 210	Counting techniques. Probability theory: Sample spaces, events, rules of probability, conditional probabilities, independent events and Bayes' theorem. Probability distributions and probability densities: cumulative distribution functions, marginal distributions, joint distributions, conditional distributions and independence. Expected values: Moments, Chebyshev's theorem, moment-generating functions, product moments, moments of linear combinations of random variables and conditional expectations. Transformation techniques of random variables. Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.
	Statistics 220	Special probability distributions: the discrete uniform distribution, Bernoulli distribution, binomial distribution, negative binomial and geometric distribution, the hypergeometric distribution, Poisson distribution and multinomial distribution. Special probability densities: Uniform distribution, gamma, exponential and chi-square distributions, the beta distribution, the normal distribution and the bivariate normal distribution. Functions of random variables. Sampling distributions, point estimation, interval estimation and hypothesis testing. Regression Analysis.

		Identification, use, evaluation and interpretation of statistical computer packages and statistical techniques.
	Economics 234	Application of the principles learned in EKN 214 on the world we live in. We look at international markets and dynamic macroeconomic models and familiarise the students with the current macroeconomic policy debates. We also take a look at the latest macroeconomic research in the world. The course includes topics of the mathematical and econometric analysis of macroeconomic issues.
	Communication management 282	Acquiring basic business communication skills will enhance the capabilities of employees, managers and leaders in the business environment. An overview of applied skills on the intrapersonal, dyadic, interpersonal, group (team), organisational, public and mass communication contexts is provided. The practical part of the module (for example, the writing of business reports and presentation skills) concentrates on the performance dimensions of these skills as applied to particular professions.
Third Year		
	Economics 310	Role of government in the economy. Welfare economics and the theory of optimality. Ways of correcting market failures. Government expenditure theories, models and programmes. Government revenue. Models on taxation, effects of taxation on the economy. Assessment of taxation from an optimality and efficiency point of view. South African perspective on public finance.
	Economics 320	Identification, collection and interpretation process of relevant economic data; the national accounts (i.e. income and production accounts, the national financial account, the balance of payments and input-output tables); economic growth; inflation; employment, unemployment, wages, productivity and income distribution; business cycles; financial indicators; fiscal indicators; social indicators; international comparisons; relationships between economic time series - regression analysis; long-term future studies and scenario analysis; overall assessment of the South African economy from 1994 onwards.
	Agricultural economics 310	Historical evolution of South African agricultural policy. Agriculture and the state: reasons for government intervention. Theoretical aspects of agricultural policy. Introduction to agricultural policy analysis. Welfare principles, pareto optimality. Macroeconomic policy and the agricultural sector. International agricultural trade.
	Agricultural market and price analysis 410	This module will focus on the fundamentals of demand, supply and agricultural price analysis. After providing an appropriate background in the theoretical concepts of demand and supply, these basics will be applied in the generation of econometric simulation models. This will include the identification of supply and demand shifters as well as the elasticities, flexibilities, and impact multipliers.

		Practical experience in the formulation of these models will be attained from practical sessions. The student will submit a project in which he/she must analyse the demand or supply patterns of a commodity of his/her choice by generating an econometric model. Agricultural price analysis: price determination under different market structures followed by practical sessions on measuring market structures in various ways. This will include the calculation of market concentration. Price trend analysis and measurement of price changes by using indexes, and especially seasonal indexing. All of this will be supported by the relevant practical sessions.
	Agricultural economics 415	Derivative instruments in agriculture: To prepare students for taking the SAFEX Agricultural Markets Division brokerage exam. Giving an in-depth knowledge on the importance of hedging. Giving an in-depth knowledge on designing and implementation of low/zero risk hedging strategies. Introduction to the mathematics of portfolio management and mathematical modelling of derivatives. Working knowledge of the mathematical relationships in the management of a hedged portfolio. Working knowledge of the applicable software for managing derivative portfolios. Introduction into the management of option portfolios. To expand the thinking on the uses of derivatives, by also dealing with the hedging of diesel cost, interest rates and weather events.
	Agricultural economics 421	Price and production function analysis. Input-output, input - input and product -product relationships; profit maximization; the production process through time, economies of size; decision making in agriculture under risk and uncertain circumstances; linear programming.
	Introduction to resource economics 424	This module reviews the origins and evolution of natural and environmental resource economics and its main present-day paradigms. Sources of externalities and causes of environmental degradation are examined. An introduction to the concepts and methods backing the design and implementation of environmental policies are provided. Economic valuation of natural and environmental resources is introduced.

Source: https://www.up.ac.za/agricultural-economics-extension-and-rural-development/article/1860707/academic-programmes