Title of Thesis: A digital skills development framework for digitally maturing South African Higher Education Institutions

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of the requirements for the degree of **Master's in Commerce**

in the **Department of Information Systems**

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Plagiarism Declaration

Declaration

Hereby, I, Ilse Kariem, declare that *"A digital skills development framework for digitally maturing South African Higher Education Institutions"* is my own original work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

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Abstract

Thesis title: A digital skills development framework for digitally maturing South African Higher Education Institutions

I. Kariem **June 2021**

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The advent of the 4th Industrial Revolution brought on an onslaught of technology rippling through a multitude of industries. Smart Cities, Smart Communities, Artificial Intelligence and Cloud Computing are but a few buzzwords of this digital age. It is argued in Information Systems that many of the challenges faced by communities can be addressed in part through the innovative use of technology. As Higher Education (HE) communities move from traditional campus communities to smart campus communities, the application and implementation of technological advancements and digital skills are needed to facilitate the transition. The disruption caused by COVID-19 virus has had a significant effect on the tertiary educational sector. This research is particularly important and relevant in a post-pandemic phase in which HE finds itself. Especially, establishing a technological and digitally equipped HE community to safeguard itself from possible future threats that impede daily operations within HE campus communities.

The primary objective of this study was to create a proposed digital skills framework to assist community members to identify the digital skills necessary to function optimally in a HE community in the process of transitioning to a smart campus community. This primary objective was reached by incorporating the Digital Skills Framework One (DSF1) and Quadruple Helix (QH) into a proposed digital skills framework. The research question was as follows: "What are the digital skills required for Higher Education communities to transition from traditional campuses to smart communities?"

To answer the primary research question, the study adopted a Living Labs methodology. The iterative nature of the methodology assisted the researchers to make ongoing corrections and adjustments to the proposed digital skills framework based on end-user group feedback. An online survey was issued to the participants that included questions of a qualitative and quantitative nature. Thereby, improving the validity of the research conducted. Participants

were purposively selected. The participant included first year, second year, third year, final year, honours and master's students studying at the University of the Western Cape.

The concurrent triangulation mixed-methods study revealed that an HE community can only transition to a smart campus community as fast and effectively as the students and lecturers are digitally equipped to manage and operate the technological advancements in the smart campus environment. The proposed framework gives a verified account of the digital skills required to function productively in a smart campus community and identified the stakeholders responsible for supplying the digital skills to the HE community members (students).

Key words: Higher Education, Smart Cities, Smart Communities, Smart Campus, Living Labs, Digital Skills Development, Digital Skills, Quadruple Helix

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"The Lord is my strength and my shield; my heart trusted in him, and I am helped: therefore, my heart greatly rejoiceth; and with my song will I praise him. The Lord is their strength, and He is the saving strength of His anointed" (Psalm, 28:7-8).

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Dedications

Daddy, this is for you.

You worked your hardest to give me the opportunities you never had growing up. For this, I will forever be grateful.

Howard Kariem, I dedicate this thesis to you as a token of my appreciation for all that you have done and continue to do for our family. Words could never express the depths of my love and appreciation for you.

May God bless and keep you always.

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List of Acronyms

Acronym	Complete name
4IR	Fourth Industrial Revolution
AR	Augmented Reality
COVID-19	Coronavirus Disease 2019
DBR	Design Based Research
DSF1	Digital Skills Framework One
DSR	Design Science Research
E-IIs	E-Inclusion Intermediaries
EMS	Economic and Management Sciences
ENoLL	European Network of Living Lab
HE	Higher Education
HEI	Higher Education Institution
ICT	Internet Communication Technology
ICU	International Communications Union
IoT	Internet of Things
IS	Information Systems
ISDSR	Information Systems Design Science Research
LL	Living Labs
LMS	Learning Management System
MIT	Massachusetts Institution of Technology
NEMISA	National Electronic Media Institute of South Africa
NesPa	National e-skills Plan of Action
OFDL	Open, Flexible and Distance Learning
SDLC	Systems Development Life Cycle
UWC	University of the Western Cape
VR	Virtual Reality
QH	Quadruple Helix

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Chapter 1: Introduction and background

Introduction

Within this chapter, key aspects of the study are presented. These themes include the increase in adoption of digital technologies by Higher Education (HE) communities in South Africa, a closer look at these digital technologies introduced in the 4th Industrial Revolution (4IR) and the digital skills required to harness them for HE purposes. In addition, the challenges South African HE communities face on this journey from a traditional to a digitally matured campus environment are discussed below. Concerns that also receive attention include the digital divide in a South African, as well as smart city and smart community concepts.

Next, the research methodology, built on the Living Labs methodology, is addressed to give a thorough overview of the research process. Finally, the gaps in current research, research problem, research questions, research objectives, significance of the study and ethical considerations are presented which highlight the pertinent areas on which the study was focused on.

1.1 Background to the study

The researchers looked at the journey of South African HE campuses as they move from being traditional, predominantly offline campuses towards being digitally inclusive campuses using 4IR or "smart", technologies optimally to enhance HE. Campuses can be seen as micro-communities that lend themselves well to the study of the transition from the traditional to the new, and the researchers viewed that researching this transition journey of a South African campus – the challenges, digital skills requirements, and the roles of the stakeholders involved - may provide insights into similar transition journeys of other (non - HE) communities. The objectives of the study were to determine the challenges faced by Higher Education campuses in South Africa as they transition from traditional campuses to digital campuses using "smart technologies", the skills required on this journey, and to identify the different stakeholder groups/individuals who will be able to solve these smart campus related challenges. The digital skills required to participate fully in the functioning of a "smart" campus, overcoming the mentioned challenges, have served as a point of departure for the investigation. COVID-19 posed a significant threat and challenge to the tertiary educational industry on a global scale (Daniel, 2020). As challenges related to the pandemic escalated, governments were forced to forbid in person interaction while promoting online communication (Daniel, 2020). This sudden shift in daily operations of students and staff has proved to have challenges. The

researcher theorises that there is a necessity for HE communities to accept and welcome the journey towards becoming a smart HE community in part to safeguard itself from possible pending threats. This is particularly important as it related to students within the HE community. Since they are the ones most likely to be vulnerable and disadvantaged in terms of technological access and digital skills required to function off-campus.

The advent of smart technology in various cities and communities has been the topic of much research in the 21st century (Lindskog, 2004; Chourabi, Walker, Gil-Garcia, Mellouli, Nahon, Pardo & Scholl, 2012; Caragliu, del Bo & Nijkamp, 2013; Silva, Khan & Han, 2018; Allam & Dhunny, 2019). According to Allwinkle and Cruickshank (2011), cities predominantly are becoming more interconnected, which allows for the flow of information from one system to another that in turn improves the effectiveness and efficiency of the overall Information and Communication Technology (ICT) infrastructure. Cities such as London, Singapore, and Melbourne are at the forefront of the development of smart cities or communities, by making use of interconnected devices to manage their ICT systems (Bakıcı, Almirall & Wareham, 2013; Calder, 2016; Dowling, McGuirk, & Gillon, 2019; von Richthofen, Tomarchio, & Costa, 2019). ICT presents an opportunity for countries to expand and develop their economic growth and social development (Hollands, 2008). Despite academic enthusiasm about the advent of smart technology in smart communities, Africa's lack of readiness for smart cities is still a significant concern (Ifinedo, 2005; Mutula, 2005; Mkansi & Landman, 2021; Olaitan, Issah & Wayi, 2021). The digital divide creates disparities that prohibit and discourage communities from understanding and accepting ICT implementations (Billon, Marco & Lera-Lopez, 2009). Moreover, of importance is the assumption that people born in the digital age are fully equipped with basic digital skills by the time they reach a tertiary level of education (Czerniewicz & Brown, 2010). Thus, it was important for the researchers to address the need for digital skills by community members (students) in an HE community. Especially in South African, HE communities transitioning towards becoming a smart campus community.

The primary objective of this study was to design a proposed digital skills framework to assist community members (students) to solve Higher Education related challenges by presenting the basic digital skills necessary to solve these challenges. This objective was reached by addressing the following primary research question: "What are the digital skills required for Higher Education communities to transition from traditional campuses to smart communities?" A Living Labs (LL) methodology was implemented to facilitate the process of designing and amending the proposed digital skills framework. The feedback generated from

the online surveys allowed the researcher to amend the initial proposed framework, which was based on the analysis of previous research. Towards the end, the proposed framework not only confirmed the digital skill shortages students face in a transitioning campus but also identified key stakeholders that could supply the necessary digital skills to students.

1.1.1 An era of smart technologies

The 3rd Industrial Revolution was marked by the birth of the internet and the advent of digitization within various industries (Lasi, Fettke, Kemper, Feld & Hoffmann, 2014). The revolution was characterised by the use of digital systems, networks, and technology (Kuni, 1997). The advancement of technology not only transformed the manner in which the manufacturing industry operated but consequently influenced social change in communities (Kuni, 1997). Since then, technological advancements have increased at a rapid rate (Lasi et al., 2014).

The 4th Industrial Revolution (4IR) is synonymous with the 21st century which has brought data-intensive and data-driven advancements in technology. This revolution has introduced industries, institutions, and communities to disruptive technologies. Disruptive technology can be defined as either the integration of an existing technologies or a new technology that creates a paradigm shift in the current operations and processes of businesses and institutions (Kostoff, Boylan & Simons, 2004). Key technological advancement within the 4IR is Cyber Physical Systems, which refer to advanced processes in which computers, through the help of algorithms and physical capabilities, can interact with humans (Baheti & Gill, 2011; Bongomin, Ocen, Nganyi, Musinguzi & Omara, 2020). The interaction can occur under different circumstances and modalities (Baheti & Gill, 2011). Another technological advancement coined IoT, otherwise known as the *Internet of Things* or the *Internet of Everything*, is making headlines worldwide. This technology's main purpose is to increase the level of interactions between devices and systems (Lee & Lee, 2015). The output of IoT is a substantial amount of data structured in a comprehensible and interpretable manner (Gubbi, Buyya, Marusic & Palaniswami, 2013). These technological advancements are in the process of completely transforming business models, operations, performance, and practices (Imgrund, Fischer, Janiesch, & Winkelmann, 2018; Haseeb, Hussain, Kot, Androniceanu & Jermsittiparsert, 2019). Another disruptive technology forming part of the group of technologies called the 4th Industrial Revolution (4IR) technologies is Cloud Computing, which is defined as a model that allows for convenient access to a number of configurable computer networks, servers and storage resources (Mell & Grance, 2011). Whereas IoT's scaling ability and capability in terms

of network connectivity is limited, cloud computing has seemingly unlimited storage and processing capabilities and these systems present a magnitude of opportunities for technological advancement (Botta de Donato, Persico & Pescapé, 2015; Díaz, Martín & Rubio, 2016).

These 4IR technologies present an opportunity to effectively solve challenges, be it community, business, or government-related issues (Manda & Dhaou, 2019). As mentioned in the Western Cape Digital Skills Shared Agenda for Action, industries and institutions are affected by technological advancements such as, Big data, Artificial Intelligence, Blockchain Technology, Cloud Computing, Internet of Things, Augmented Reality (South Africa, Department of Economic Development and Tourism, 2018). Internationally, universities are making use of advanced technology to assist industries and to better their own environment. For example, the top-ranking college, Massachusetts Institution of Technology (MIT) is at the forefront of technological innovation, assisting industries, communities and their campus environment to consistently improve and find innovative solutions to challenges. Their programmes include Virtual Reality (VR) and Augmented Reality (AR) at MIT, MIT Robotics Team, MIT Electronic Research Society and TECHX. All these programmes mentioned above are student-run organisations (MIT innovation initiatives, n.d). This adoption of technology in the tertiary educational sector demonstrates the ability of campuses to adapt and transition into effective and efficient technologically advanced communities equipped with the digital skills to operate daily tasks.

1.1.2 Smart cities and smart communities

The terms "smart city" and "smart community" are particularly difficult to define. Depending on which area of literature you consult, a smart city may be defined as an *Intelligent city, Sustainable city, Wired city, Digital city, Information city, Virtual city, Green city or Knowledge city* (Schuler, 2002; Couclelis, 2004; Ergazakis, Metaxiotis & Psarras, 2004; Komninos, 2006; Hollands, 2008; Anthopoulos & Fitsilis, 2010; Bătăgan, 2011). The inception of smart city concepts has posed a multitude of challenges. According to Tranos and Gertner (2012), although efforts and emphasis have been made regarding the development of ICT in urban development, the indicators of what differentiates smart cities and communities from less smart ones has previously been undetermined and unclear. Given that smart cities were once a relatively new concept, there was little body of knowledge as to the characteristics, concepts, and practices of a smart city and smart communities. Thus, previously contributing to the lack of understanding of what a smart city and by association, a smart community was.

In previous research smart cities have been defined as the integration of existing infrastructure and information technology to facilitate positive change within cities (Batty, Axhausen, Giannotti, Pozdnoukhov, Bazzani, Wachowicz, Ouzounis & Portugali, 2012). A contemporary definition primarily focuses less on infrastructure and more on the integration of networks, communication technology and infrastructure to better the socio - economic and environmental areas of citizens lives (Ismagilova, Hughes, Dwivedi & Raman, 2019). Moreover, much of the current body of knowledge emphasises the need for (1) active participation of community members and (2) basic and advanced digital skills among citizens within smart cities and communities (Tryfonas & Crick, 2018; Yusuf, Alamsyah, Syarif, Muh, Muntasa & Muzakki, 2019). Participation in the context of this study refers to the inclusion and active involvement of community members by giving the students the opportunity to stipulate challenges they have experienced on campus and the digital skills they think they need to function optimally in a smart HE community. In terms of this study, the researchers defined smart cities and communities as a network of active participants and stakeholders, infrastructure, communication technology, and digital capabilities used in the best possible way to improve the social, environmental and economic conditions/challenges of community members (Tryfonas & Crick, 2018; Ismagilova et al., 2019; Yusuf et al., 2019). The researcher affirms that every community has challenges. Thus, the researcher, as a starting point identified the challenges students experienced in the HE community and thereafter determined the digital skills the students require to solve those challenges.

1.1.3 Community related challenges

Solving community problems, such as the challenges faced by traditional campuses when transforming to digital campuses, through the use of technology or digital skills development programs is a well-researched field of study in Information Systems (IS).

ICT developments, including Smart/4IR implementations, present an opportunity to aid and assist developing countries (communities) as they engage with community-level challenges (Ndou, 2004; Avgerou & Walsham, 2017; Jordaan, Malekian & Malekian, 2019). However, Silva, Khan and Han, 2018 contended that much of the unsuccessful implementation of ICT developments in developing communities is a direct result of challenges related to implementing and integrating smart technology into community members lives. Similarly, Castells (1997), and Castells and Blackwell (1998), theorised that technology can further aggravate disadvantaged communities' socio-economic conditions. Other authors contend that the current assumption that ICT implementations can be used as a means of development in a

digitally divided community, is an ill-advised discourse (Wade, 2002; Warschauer, 2003). Scholars argue that the true measure of ICT's impact depends on the technologies ability to adapt to the social, political, and economic climate in which it exists (Heeks, 2002; Gigler, 2015).

A study conducted by Gigler (2015), contended that when disadvantaged citizens have the ability to utilise and manage data, they can improve their political, social, and financial freedom. The results of the study have determined that in order for ICT to have a positive impact on the lives of poor citizens, individuals' *information capabilities* should be addressed and enhanced (Gigler, 2015). The current body of knowledge contends that the purposive use of technological advancements can aid communities plagued by environmental challenges and move them from traditionally inhibiting circumstances towards better futures. The researcher placed emphasis on determining the digital skills students require to solve the challenges they experience with the use of technological advancements.

1.1.4 Digital skills in South Africa

The relationship between advancements in infrastructure - technologies available for use in an environment - and the skills needed to use such technologies was part of the focus area of this study. As communities move from traditional to digital ways of working and living, the digital skills required by citizens increases.

Many authors contend that ICT can greatly improve citizens' ability to solve or reduce the challenges faced on a daily basis, thereby reducing poverty, inequality, and resolving issues associated with health services, quality education and environmental factors (Das, 2019; Majeed & Khan, 2019; Hatakka, Thapa & Sæbø, 2020). Although ICT development within South African communities is necessary, there still remains a need for digital skills development. South African individuals with the necessary basic and advanced digital skills to resolve community level challenges using technology are relatively few (After Access, 2018). Digital skills can be defined as the operational or content related digital capabilities for individuals to strategically navigate digital services and products (Van Deursen & Van Dijk, 2011). The International Telecommunication Union (ITU) has determined that only 46% of citizens residing in developing countries have basic digital literacy skills (ITU, 2018). In an article aligned with the views of After Access (2018), Van Audenhove and fellow researchers Marien, Craffert and Grove (2018), discussed the severity of the lack of e-skills in South Africa, and how this lack prompted the then President Thabo Mbeki to establish the Presidential

International Advisory Council in 2007 to address the ICT related challenges, specifically focussing on the lack of e-skills (digital skills) amongst South African citizens. As a result of this initiative, The National e-skills Plan of Action (NesPa) was introduced to research and address skill shortages in South Africa (Van Audenhove et al., 2018). Since then, NesPa has merged with the National Electronic Media Institute of South Africa (Nemisa) to develop the e-skills capacity, and capabilities of South African citizens (South Africa. National Media Institute of South Africa, 2019).

It is within this context of an observed lack of digital literacy and digital skills in South Africa, that this study proposed to focus on digital skills to accelerate the transitional processes followed by HE campuses. This context is fully explored in the Literature Review in Chapter 2. Background information related to multi-stakeholder relationships are discussed in the next section.

1.1.5 Quadruple Helix

Solving community-related challenges using innovative solutions is a driving force in developing countries (Zvieriakov & Zavadska, 2018). As a result, several helices have been constructed as frameworks for thoughts around how to solve community-related socio-economic challenges (Carayannis & Campbell, 2010; Zvieriakov & Zavadska, 2018). Numerous conceptual frameworks such as the Triple helix, Quadruple helix, Quintuple helix and *N*-tuple helix have been designed in an effort to comprehend the complex relationship among actors or stakeholders such as the university, civil society, government and industry (Nordberg, Mariussen, & Virkkala, 2020). The use of a specific helix depends on the shared vision of the parties involved (Kolehmainen, Irvine, Stewart, Karacsonyi, Szabó, Alarinta, & Norberg, 2016). An increasing number of businesses, communities and nations are engaging in multi-stakeholder relationships with the vision of creating innovations for the purpose of creating shared value (Russell & Smorodinskaya, 2018). The complexity of the relationships among the actors are discussed in Cunningham, Menter and O'Kane (2018), study where the researchers argued that the relationships within helices are oversimplified, innovation is rather created by individuals and deemed valuable by the other actors involved. Thus, it is imperative to analyse the need for a specific helix on a micro level to ensure value is created within the community it aims to serve (Cunningham et al., 2018). The complexity of the relationships within the QH has been mediated by the fact that this study will effectively focus on solving pertinent issues per campus community challenge, thereby localizing the relationship to each individual challenge within the HE community.

The Quadruple helix involves the process of co-creation amongst four main industries: Firms, Civil Society, Government and Research Institutions (Nordberg et al., 2020). For the purpose of this study, each helix reflected either on the demand or the supply side of the two-sided market. Civil society which includes the university students are on the demand side, as they are in need of digital skills. Reason being, that the HE community members will ultimately be the recipients of the digital skills. Government, University as an institution and Industry are subsequently on the supply side, as they are responsible for providing civil society with basic and advanced digital skills, infrastructure and technological solutions to solve social and economic challenges. Thus, the proposed digital skills framework identifies the key stakeholder groups/individuals in the innovation process to ultimately assist students by providing them with the necessary digital capabilities to function in a smart HE community.

1.2 Gaps in current research

Despite thorough research as to the causes and challenges regarding the lack of digital inclusion in Africa, studies focussing on the lack of digital skills in South African HE communities are slim to none (West, 2015; Bornman, 2016). Few researchers have addressed the lack of basic digital skills among South African HE community members. The digital skills required by students to function optimally in a smart campus community in a South African context have not yet been critically addressed. An opportunity arises for South African HE communities to adopt the proposed framework not only to address the digital skills shortages but also to determine the stakeholders involved in supplying community members with the necessary digital skills. The research conducted in this study serves as a starting point to explore whether the proposed framework can be used and replicated in other ICT projects and studies at Higher Education Institutions (HEI's) and other educational communities.

1.3 Statement of the research problem

The problem statement for the study was that universities face different challenges transitioning from a traditional HE community to a smart HE community. These challenges can be solved by developing a framework to address the underlying digital skills shortcomings in HE communities. Universities are yet to create a framework describing the lack of basic and advanced digital skills in their communities as they move towards becoming smart communities. As an example, it is important for community members to comprehend the implementation of ICT systems on a design level in order to see the value and benefits ICT systems will bring to the community. There is, however, an observed lack of such technical understanding within community member user groups when designing systems that are

intended to address the identified challenges within their smart communities. Hence, the study posited that the creation of a framework can assist university management and end-user groups to address the lack of digital skills by delineating the digital skills shortages and by identifying key stakeholders in the community in order to solve campus related challenges effectively.

1.3.1 Research objectives

The primary objective of this study was to create a proposed digital skills framework to assist community members to identify the digital skills necessary to function optimally in a HE community in the process of transitioning to a smart campus community. Moreover, several sub-objectives were established in order to achieve the primary objective. The sub-objectives were as follows,

- To define from literature and previous research, the challenges experienced by higher education communities moving from a traditional campus to a smart campus community.
- To define from literature the digital skills needed to solve smart campus related challenges.
- To verify from end user engagement which digital skills are related to which challenges.
- To verify from end user engagement the stakeholders with critical responsibilities for the development of the identified digital skills.

1.4 Alignment of primary research question, sub – questions, methods and research objectives.

Table 1: Alignment of primary research question, sub – questions, methods and research objectives

Research Question: What are the digital skills required for Higher Education communities to transition from traditional campuses to smart communities?		
Sub- questions	**Methods**	**Objectives**
1. What are the challenges experienced by higher education communities moving from a traditional campus to a smart campus community?	Analysis of literature	To define from literature campus related challenges and categories.

Sub-questions	Methods	Objectives
2. What are the underlying digital skills needed to solve smart campus related challenges?	Analysis of literature	To define from previous research the skills needed to solve campus related challenges.
3. What digital skills do end-users see as related to solving which of the defined challenges?	Data collection: Online Survey	To determine the digital skill needed within a smart campus community.
4. Who are identified by end-users as stakeholders with critical responsibilities for the development of the identified digital skills?	Data Collection: Online Survey	To verify from end user engagement the stakeholders with critical responsibilities for the development of the identified digital skills.

1.5 Delineation: The scope of the study

This study was geographically confined to the University of the Western Cape, situated in the city of Cape Town, in South Africa. More specifically, only current and former students, who have completed or who are completing their studies at UWC. The study aimed to delineate the digital skills necessary for students to function as a productive citizen in a campus community transitioning from a HEI to a smart campus community. The DSF1 was incorporated into the proposed digital skills framework to establish the basic digital skills students need to acquire to function productively in a smart campus community. The DSF1 was limited to a set of *basic digital skills* and *user skills* that individuals need to be productive members in today's digital driven society (Claassen, 2017).

However, the participants were given the opportunity to share additional digital skills they deemed necessary to function optimally in a smart campus community. The confines of the study gave the researcher the opportunity to gain rich insight into the perceptions of students related to their need for digital skills and the stakeholders necessary to supply digital skills in a transitioning HE community.

1.6 Methodology

"A new trend in user involvement in open innovation processes has emerged" (Bergvall-Kårenborn, Eriksson, Ståhlbröst & Svensson, 2009). This trend includes end-user groups in the innovation process to guarantee functional and effective products and services (Bergvall-Kåreborn et al., 2009). Although end - users can add value to the product or service, they need a thorough understanding of the product or service being implemented. In order to involve end-users in the innovation process, a specific design process needs to be followed. One such design process is the Living Labs methodology. The European Network of Living Labs (as cited in Schuurman, 2015), defined Living Labs as an open-innovation ecosystem where users openly form part of a design process. It is imperative that the addition of technological advancements adds value and is beneficial for the community. The Living Labs methodology consists of mainly four activities, namely, "co-creation, exploration, experimentation, and evaluation" (Schuurman, 2015:133).

These activities assisted the researcher to amend the proposed framework through two iterations based on the participants feedback from the online survey. The cross - sectional study selected a group of students including undergraduate and postgraduate UWC students studying in the field of Economic and Management Sciences (EMS). Two iterations of the online surveys were conducted with the purpose of amending the proposed framework by means of the various insights and perceptions gained from the participants.

1.7 Significance of the study

The conceptual framework designed by the researcher proposed to identify the digital skills needed to solve campus related challenges. Additionally, the framework determined each stakeholder groups/individuals involved in the innovation process to supply digital skills to students. The framework has three components. One is to identify the challenges the University of the Western Cape is currently experiencing. The second component is to identify the digital skills needed to solve the challenges. Finally, the stakeholder groups/individuals involved in supplying the digital skills to community members were identified.

The researchers aimed to design a proposed digital skills framework to address shortcomings of digital skills in HE communities. Furthermore, the researchers added to the current body of knowledge in terms of research regarding smart campus development in South Africa. The transition from a traditional campus to a smart campus community has been under researched in South African academic literature. Thus, the present study is expected to add clarity to the

fog surrounding smart campus community concepts, the need for digital skills, and digital inclusion in a South African HE context.

1.8 Layout of the dissertation

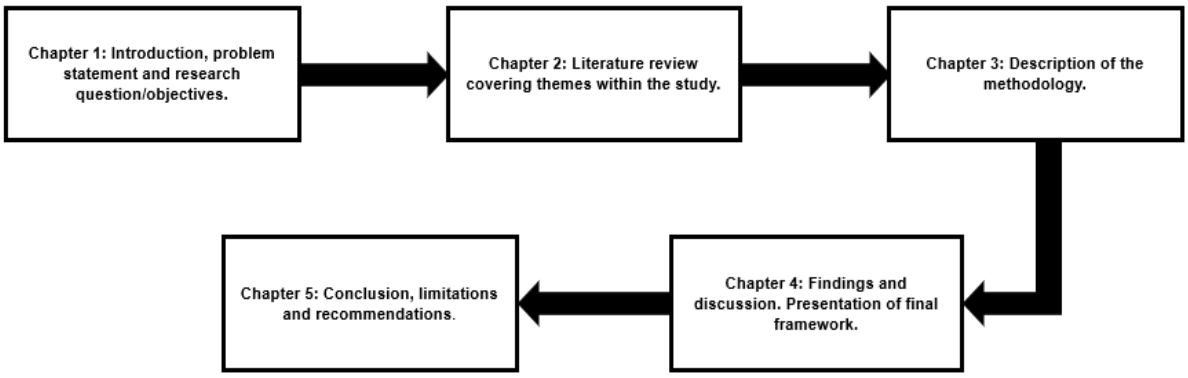


Figure 1: Layout of the dissertation

1.8.1 Chapter 1: Introduction and background

The first chapter presents an overview of the theoretical and methodological context of the study. This chapter puts emphasis on background information, the research question, research objectives, problem statement, gaps in current research, and the contribution the study will make to the current body of knowledge in the Information Systems discipline.

1.8.2 Chapter 2: Literature review

Chapter 2 highlights existing research related to the key focus areas of the study. The key focus areas are discussed in detail. Additionally, the Digital Skills Framework One presents the reader with the opportunity to understand the importance and relevance of the framework in the study.

1.8.3 Chapter 3: Methodology

The third chapter discusses the stages in the research process as well and gives an account of the two iterations taking place in the study. Saunders, Lewis, Thornhill (2019), 'research onion' will form the basis of Chapter 3. Stages in the research process are the philosophical discourse, research approach, methodological choice, research strategy, time horizons, research techniques, and procedures.

1.8.4 Chapter 4: Findings and discussion

Findings pertaining to the first and second iteration cycle are presented in Chapter 4, along with a discussion about the findings as interpreted by the researcher. The results of the two

iteration cycles form the basis of this chapter as the researcher; interpret the findings based on the feedback of the participants.

1.8.5 Chapter 5: Conclusion

The final chapter presents the conclusions, recommendations, and limitations of the study. Furthermore, the chapter aimed to identify whether the research question has been answered and the research objectives have been reached. Additionally, opportunities for further research are addressed.

1.9 Chapter summary

Chapter 1 sought to establish the background information of the topic of the study namely, "A digital skills development framework for digitally maturing South African Higher Education Institutions". The rationale to conduct the research was identified by describing the background information, the significance of the study and gaps in current research. In addition, the research problem was stated, followed by the research questions and the objectives. The case study population and sample were outlined to give insight into the need for using a purposeful selection of participants. The chapter concluded by showcasing each of the research chapters. The final section provided an overview of the salient points discussed in this chapter.

The following chapter discusses the key focus areas of the study. In this sub-section will provide an overview of the salient points discussed in this chapter.

Chapter 2: Literature review

2.1 Introduction

Following the theoretical scope detailed in the previous chapter, this section will report on the existing body of knowledge based on the main ideas presented in Chapter 1. The research question, objectives, contribution of research, ethical considerations and thesis outline were presented in the previous chapter. The researchers accepted the fact that to create an effective proposed digital skills framework, previous research must be considered and analysed. As a result, this chapter looks at the advent of smart campus communities, the smart city maturity model, digital skills, Quadruple Helix (QH), and the existing Digital Skills Framework One (DSF1). Towards the end of the Chapter, a proposed framework is presented to illustrate not only the challenges HE communities face when transitioning to a smart campus community but also the stakeholder groups/individuals that need to be involved to address the shortage of digital skills in HE communities. This initial proposed framework has been exclusively based on previous research (see Section 2.9).

2.2 Smart Campus community

The researchers sought to determine the digital skills required by students to function optimally in a smart campus community. The difference between a traditional campus and smart campus community can be found in Haggans (2016), study. Haggans (2016), noted that traditional campus communities are characterised by in-person exchanges between staff and students, physical attendance of classes, established premises, designated areas for research, and library books. While smart campus communities are characterized by online interaction between students and staff, integrated administrative systems, community members with knowledge and digital skills to use and manage campus resources, a technology-intensive environment, global integration and exchange of academic research (Haggans, 2016; Villegas-Ch, Palacios-Pacheco & Luján-Mora, 2019). In terms of this study, smart campus communities are a mirror image of smart cities but on a smaller scale. As a result, the definition and description of a smart campus community has been derived from (Sutjarittham, Gharakheili, Kanhere and Sivaraman, 2018:1) study which states “Large university campuses are like mini-cities: they occupy several acres of land; they contain various spaces and facilities such as office buildings, lecture halls, libraries, informal study rooms, retail spaces, car parks, and public transport stops; they are populated with tens of thousands of people; they host a dynamic flow of human activities from students and staff to contractors and general visitors, each with different needs

and profiles; and they are under constant pressure to provide better services to stakeholders while reducing costs". According to (Chuling, Zanfu & Peng, 2009), one of the key challenges' executives at HE communities face is managing the large pool of citizens, and the various services and projects that exist within a smart campus community. In terms of this thesis, the researcher refers to a study conducted by Villegas–Ch et al. (2019), detailing that smart campus communities are ecosystems that experience an array of challenges. These authors have determined that challenges can be managed with the help of ICT advancements to improve the access of citizens to safety and security measures, efficient mobility and environmental sustainability (Villegas–Ch et al., 2019). The advancement of technology has significantly impacted different industries including HE (Mattoni, Pagliaro, Corona, Ponzo, Bisegna, Gugliermetti and Quintero-Núñez, 2016). The purpose of developing a smart campus community is to manage expenditure and risk, to ensure effective and efficient use of campus resources, to provide services supported by advanced technology and to ensure growth and sustainability within the community (Kwok, 2015; Alghamdi & Shetty, 2016; Malatji, 2017; Pereira et al., 2018; Min-Allah & Alrashed, 2020). Similarly, Muhamad et al. (2017), stated that a smart campus community should not only focus on improving learning activities but should incorporate advanced technology to support environmental, health and governance systems of the HE community.

Pagliaro et al. (2016), deemed smart cities to be complex structures that are identified by predetermined characteristics. Viewing an institution of HE as a smart community, a researcher can identify characteristics that determine the complexity within a smart campus. The characteristics are as follows:

Complexity: A fundamental challenge HEI's experience is the level of complexity of practices and processes which occur in their community and how much influence management has over the processes. Examples of complex systems are environmental sustainability, economic growth, and in terms of this study, smart campus environment.

Diversity: The wide variety of HEI's results in there being many differences between these institutions. These differences can range from geographic and demographic to economic structures. Diversity adds to the complexity of functions within a university environment. The increase in diversity in functions on campus invariably lead to the increase in actors needed to manage university policies.

Uncertainty: Volatile and constant changing environments puts strain on forecasting efforts to manage a campus community. The future and its unpredictable nature are a constant challenge that risk assessors and planners need to consider.

Sustainability: A wide variety of stakeholders form a major part of a university's ecosystem. The needs of stakeholder groups/individuals can be met by ensuring growth through sustainable development initiatives identified throughout university policy.

The smart campus researcher has based this study on the University of the Western Cape (UWC) situated in South Africa. UWC is a large community with approximately 20 500 students and staff members working and living in its vicinity (University of the Western Cape, 2013). UWC presents indicators of a campus community in the process of transitioning from a traditional campus community towards a smart campus community. Pre – COVID-19, UWC's classes were mainly face-to-face interaction, exchanges with UWC personnel were mainly in person, and UWC was predominantly limited to its physical premises. During the global pandemic UWC has made technologically driven changes to assist students and staff with their daily tasks. UWC has implemented integrated administrative systems, predominantly online classes and online interaction between staff and students.

The researchers aimed to determine what digital skills students need to function optimally in the smart campus environment. The following section looks at a maturity model of a smart city to identify the different phases needed to effectively implement smart city concepts and technology in an HE community.

2.3 Smart community maturity model

The transition from a traditional community to a smart community is an intricate process which requires thorough deliberation about the processes, not only technology and digital skills needed in a smart community, but also about the planning to ensure deliverables are met, and the implementation of smart technologies with the vision of designing a sustainable environment (Deloitte, 2015). According to the Smart Cities report written by Deloitte (2015), a traditional community that envisions transitioning into a smart community needs to follow a set of phases. Deloitte developed a maturity model to establish the phases for a transitioning community. These phases include, "initial, intentional, integral, and transformed" (Deloitte, 2015:36). The researchers of this thesis viewed the transition from a traditional HE campus to a smart campus environment as a roadmap. Each phase is depicted in Figure 2, illustrates each phase of a traditional HE community maturing into a smart campus community. The roadmap

is based on the Deloitte model. The revised phases include *foundational, core services, integration and transformation phases*. Each phase presents its own challenges. The author of this thesis has theorised; these challenges can be solved by supplying campus community members with the necessary digital skills. The study aimed to establish the digital skills necessary for students to function optimally within a smart campus community. The phases to establish a smart campus community are presented in the next section.

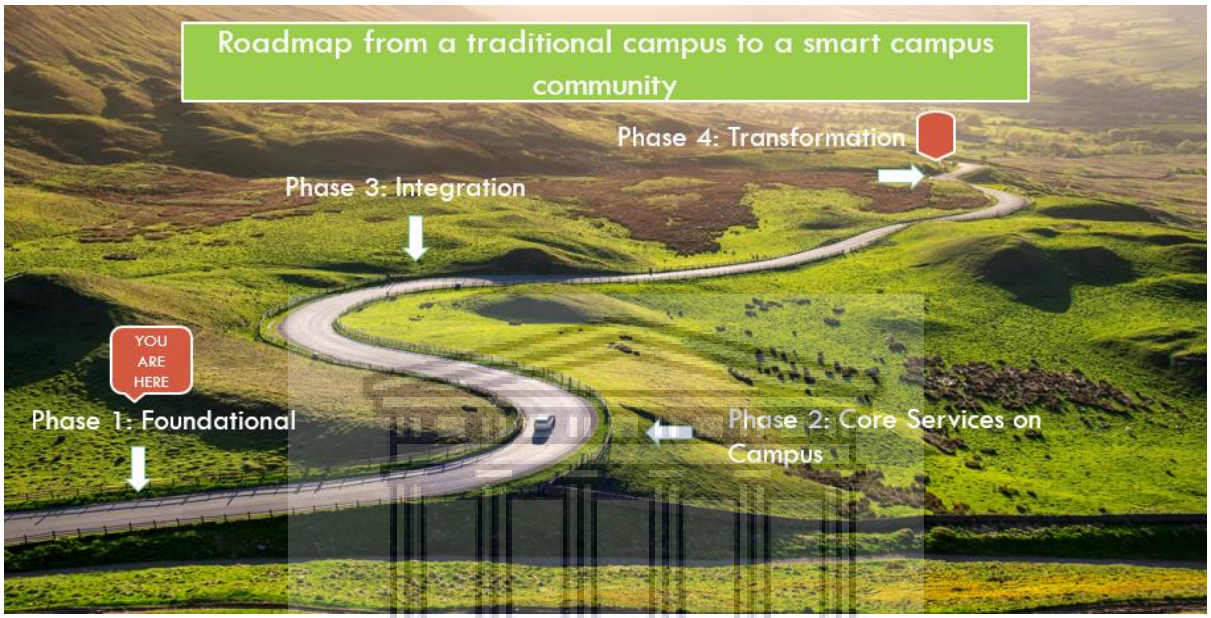


Figure 2: Roadmap to a smart campus community (Source: author)

2.3.1 Foundational phase

In order for a traditional campus to transition into a smart campus community certain fundamental components related to the transitioning need to be in place. These components include network/internet availability, access to data and digital devices (on/off-campus), and efficient mobility of students both on and off campus. The components presented are challenges until solved by a university. Table 2 illustrates the foundational challenges HE communities face when transitioning to a smart campus community. In addition, a definition of the challenges and the corresponding sources of academic literature are listed within the table.

Table 2: Foundational challenges definition

Foundational Challenges			
No	**Challenge**	**Definition of challenge**	**References**
1	Access to devices	Digital devices can be defined as technological developments such as electronic devices, electronic systems, and networks that create, store, distribute, and automates data to present usable information. Access to digital devices needs to be a priority for a HE community transitioning to a smart campus community. Additionally, the study theorises that when HE community members do not have the necessary digital skills to operate and manage digital devices, they will be highly unlikely to transition successfully into a smart campus community.	After Access (2018) Roztocki, Soja & Weistroffer (2019)
2	Access to internet connectivity	A key determinant of a smart community is the ability for community members to connect to the internet via broadband or Wi-fi services. Access to broadband and the ability to afford broadband services is a critical challenge South African citizens experience. The study theorizes that in order for an HE community to transition to a smart campus community, students will need access to Wi-fi/Broadband services.	After Access (2018) Evans (2018)
3	Digital skills literacy	Digital skills can be defined as a set of capabilities related to operating and managing data using technological developments. As HE communities' transition from a traditional campus environment to a smart campus community, certain digital skills are required for the members of the community to function optimally when operating the technological developments. The study theorises that students' need basic digital literacy skills to function confidently in a smart campus community.	van Laar, van Deursen, van Dijk & de Haan (2017) Bond, Marín, Dolch, Bedenlier & Zawacki-Richter (2018)
4	On and off - site mobility	On and off-site mobility refers to a student's ability to receive class lectures and resources whilst not physically attending class. Open, flexible and distance learning (OFDL) does not require a student to adhere to a set time, location, learning method or educational path. This study theorises that as an HE community transitions from a traditional to a smart campus community teaching practices between student and learners needs to be flexible. Additionally, in order to facilitate the transition from physical classrooms to online options of learning, students will need the necessary digital skills to make use of the online learning platforms and applications.	Naidu (2017) Müller et al. (2018)

2.3.2 Core services phase

Once a university implements all the elements needed within the foundational phase (access to devices, internet and basic skills induction), it can determine how to improve their primary services on campus. The core services describe the services rendered within an HE community.

These services ensure that student needs are met. Core services in an HE community includes the physical safety of students and privacy related to personal information, teaching and learning initiatives, and administration related to students' profiles and data. Table 3 illustrates the core services challenges HE communities face when transitioning to a smart campus community. In addition, definitions of the challenges and the corresponding sources of academic literature are listed within the table.

Table 3: Core services challenges definition

Core Services Challenges			
No	**Challenge**	**Definition of challenge**	**References**
5	Physical safety of students	Physical safety is critical within the borders of a campus community in order for students and staff to learn and teach successfully. Lack of safety within the campus environment can include theft of personal items, sexual harassment, rape, stalking, bias-related violence, disorderly conduct in classrooms, arson, suicide attempts, physical harm, destruction of property and riots. Other threats to the physical safety of students are natural disasters. Students and staff need to feel safe in the environment in which the study and work. This study theorises that the use of technological advancements can aid the student to in turn feel safer on campus. However, students require the necessary digital skills to make use of the technological safety additions in the smart campus community.	Langford (2004) Zhang, Suo, Chen, Liu & Gao (2017)
6	Data privacy	Privacy in terms of protection of your personal data is of critical importance in a campus community. Many threats exist to compromise and steal certain personal information. In the midst of the COVID-19 pandemic, HE communities were forced to interact and transact online. Thereby, increasing threats related to online privacy concerns. Students need to be equipped with the necessary knowledge and digital skills to interact online, share information, and transact safely online.	Reidenberg & Schaub (2018) Komljenovic (2020)
7	Student administration	As a result of the pandemic, many of the services the case study institution offers have been moved online. Some of these activities include online classes, registration and electronic payments. However, students may still face challenges using these university services.	Aldowah, Rehman, Ghazal & Umar (2017) Al_Janabi, (2020)
8	e - Learning	E-learning can be defined as an online platform where educational tools, material, and resources are shared between students and lecturers. It is evident from literature that universities across the world are experiencing an increased demand for online educational services. However, some university programmes do not allow for flexibility in terms of attendance. University rules sometimes require students to be present and accounted for during online as well as in-person classes	Al-Fraihat, Joy & Sinclair (2017) Al-Samarraie, Teng, Alzahrani & Alalwan (2018) Al-Fraihat, Joy & Sinclair (2020)

No	Challenge	Definition of challenge	References
9	iKamva (LMS)	iKamva is a Learning Management System (LMS) used by the case study institution staff and students to facilitate the majority of online activities as related to course material. Students receive course resources from the lecturers, participate in forums and submit assignments. Navigation of this platform is a challenge for community members. All students are not equipped with the necessary digital skills to navigate iKamva.	Zanjani (2017) Ghazal, Al-Samarraie & Aldowah (2018)

2.3.3 Integration phase

Once the core services of a campus community have been improved (sufficiently digitized), it is then important to assess the state of further areas of the university and determine how to integrate these areas into the digital lives of students and staff. The areas of concern within the integration phase are, quality of life as it pertains to students' unique experience at university, access to health and wellness services, and availability of quality food products and services. Table 4 illustrates the integration challenges HE communities face when transitioning to a smart campus community. In addition, definitions of the challenges and the corresponding sources of academic literature are listed within the table.

Table 4: Integration challenges definition

Integration challenges			
No	**Challenge**	**Definition of challenges**	**References**
10	Lack of innovative spaces	Traditional learning spaces are classrooms that include immobile furniture, assigned seating points, and a lack of technological advancements. The purposive use of ICT presents an opportunity for universities to enhance their learners' performance, learning capabilities and social interactions. Study areas are crucial to the productivity of students on campus. The majority of students make use of these campus areas to study, work in teams, and attend to their individual assignments. Innovative study areas give students the opportunity to improve their motivation and quality of life on campus. Innovative learning spaces can foster open innovation among students by incorporating flexible furniture and technologies. This means that, an HE community that endeavours to transition to a smart campus community has to ensure that students have the necessary digital skills to operate and manage the ICT developments within the smart classrooms/study areas.	Abdellatif (2019) Kariippanon, Cliff, Okely & Parrish (2019)
11	Health and Wellness	COVID-19 has presented many challenges in the campus communities across all South African HEI's. The health and wellness of employees and of students have taken centre stage in order to ensure that the campus community remains safe from immediate health threats. Additionally, COVID-19 has presented an unfortunate rise in mental health issues related to anxiety and depression. As HE communities move back to campus, there is a need to consider how to assist students with their physical and mental health. This study theorises that as a traditional campus community moves towards becoming a smart community, ICT developments can aid both the healthcare practitioner and student to engage and interact. However, students need adequate digital skills to operate the technology available to them.	Naidoo & Cartwright (2020) Pownall, Harris & Blundell-Birtill (2021)
12	Food security	Food security is a key aspect of any smart campus community. The pandemic has presented grave challenges related to food security among the disadvantaged groups in South Africa. Moreover, with the rise in tertiary educational costs and the cost of living, more disadvantaged students experience food shortages and hunger. Food shortages and scarcity are grave issues in underprivileged communities in South Africa. It is critical to assess the research conducted concerning the availability of food on campus to ensure that daily needs of students and staff are met, and that sustainability of food supply and production is achieved. An HE community transitioning into a smart campus community has the ability to use ICT developments to implement sustainable food production and distribution on campus. However, the study theorises that students play a crucial role in the sustainability agenda and therefore need the necessary digital skills to operate the technological developments on campus.	Van den Berg & Raubenheimer (2015) Arndt, Davies, Gabriel, Harris, Makrelov, Robinson, Levy, Simbanegavi, van Seventer & Anderson (2020) Broton, Weaver & Mai (2018)

2.3.4 Transformation phase

The final step within the innovation process is the transformation phase. In this phase, the foundational, core services and integration services have been optimized and streamlined on campus using technology. However, it is important to note that this is an iterative process that requires those involved to always re-assess, re-test and monitor, and change processes within the previous phases if they are deemed outdated or irrelevant. The transformation section ensures that sustainable goals are met and that community members always look to establish growth within the community. Table 5 illustrates the transformation challenges HE communities face when transitioning to a smart campus community. In addition, definition of the challenges and the corresponding sources of academic literature are listed within the table.

Table 5: Transformation challenge definition

Transformation Challenge			
No	**Challenge**	**Challenge definition**	**References**
13	Sustainability and growth	The final challenge presents an opportunity for HE communities to continuously grow and improve their processes, practices, and investment in technological advancements. However, community members need to accept and invest in the idea of an ever-changing environment. Considering that the majority of the infrastructure, processes and basic technological developments are implemented in the phases mentioned above; it becomes possible for a campus to implement new, 4th Industrial Revolution technologies, such as sensors, cameras for detecting movement, and automated support services like robots and chatbots. The involvement of students within these developments is closely related to the successful use of these developments. In a smart campus community, innovation need to be involved with incorporating students to create and develop a sustainable environment in which they can confidently carry out their daily tasks. Thus, ongoing investment in digital skills is required to understand, manage, and operate all the technological advancements within a smart campus community.	Blanco-Portela, Benayas, Pertierra & Lozano (2017) Murray (2018)

2.4 Digital skills

The proliferation of previous research in the field of ICT related capabilities generated a variety of terms defining digital skills. The terms include “digital skills’, “digital literacy”, “ICT skills”, “e-skills”, “internet skills”, “digital competence” and “technical competence” (Goodyear, Salmon, Spector, Steeples & Tickner, 2001; Merkofer & Murphy, 2009; Buckingham, 2010; Van Deursen, Van Dijk & Peters, 2011; Van Dijk, & Van Deursen, 2014; Carretero, Vuorikari & Punie, 2017). The 21st century digital skills as discussed in the Van

Laar, Van Deursen, Van Dijk and De Haan (2019) study, set out to analyse the prevailing nature of digital skills in relation to "creativity", "collaboration", "information", "critical thinking" and "problem solving". As a result of the study, the researchers designed a digital skills pathway. Towards the end of their study, the researchers concluded that in terms of viewing digital skills as a pathway, if an individual lacks a particular digital skill, they will likely lack other skills, provided that digital skills are interrelated and sequential to one another (Van Laar, Van Deursen, Van Dijk & De Haan, 2019). The researchers contest that for an individual to thrive in the 21st century labour market, they need digital skills related to creativity, collaboration, information, critical thinking and problem solving to reap the benefits of their employment (Van Laar, Van Deursen, Van Dijk & De Haan, 2019). Similarly, a literature review conducted by Van Laar, Van Deursen, Van Dijk and De Haan (2017), to account for all the necessary digital skills needed in today's society. Moving from traditional technical skills to a broader spectrum of capabilities needed to functional as a knowledge worker. The researchers initially screened 1592 articles and after a thorough analysis focused on just 75 of them. Towards the end, the scholars designed a framework of 21st century digital skills which provided definition and operational instructions in the pursuit of stipulating the most prominent digital skills needed in the 4IR. This framework encapsulates 12 digital skills such as, "technical", "information", "information management", "communication", "collaboration", "creativity", "critical thinking", "problem solving", "ethical awareness", "flexibility", "self – direction" and "lifelong learning skills" (Van Laar et al., 2017:583). However, these digital skills reflect only one aspect of individuals' digital competence. Other areas of digital competence include, and individuals established knowledge, perceptions and attitudes towards digital devices and digital skills (Langset, Jacobsen & Haugsbakken, 2018).

Readiness for the Future (2018) report conducted by the World Economic Forum, stipulated each country's readiness and compared it to South Africa's current technological state. Subsequently, South Africa was ranked 67th out of 100 countries, in terms of the lack of human capital (World Economic Forum, 2018). Furthermore, the report contends that South Africa ranks 94th among 100 countries in terms of the proportion of citizens who have the necessary digital skills in the country (World Economic Forum, 2018). Another report, titled *Automation Readiness Index* maintains that South Africa ranks 22 out of 25 countries pertaining to their current abilities and strategies to exploit opportunities and solve community-related challenges by means of intelligence automation (Economic Intelligence Unit, 2018).

The researchers with the help of an online survey had to establish what digital skills students currently have. Once the students' current digital skills were determined the researcher had to establish what digital skills the student will need to solve these challenges of a traditional campus transitioning into a smart campus community. The Digital Skills Framework One was used to determine the digital skills required by students to function confidently in a smart campus community.

2.5 Digital Skills Framework One

The Digital Skills Framework One (DSF1) as developed by Claassen (2017), has been designed to provide a holistic view of the digital skills needed to function productively in today's society. The use of the word "One" merely indicates that this framework is a top-level view of the various digital skills needed to different areas of life (Claassen, 2017). However, it is important to note that the researchers did not view this framework as the holy grail of the digital skills framework, but rather considered the framework as a general top-level to lower-level view of the set of digital skills necessary to function in today's society (Claassen, 2017). The researcher stated that digital skills should be applicable and relative to specific areas of life (Claassen, 2017). These specific areas can be defined as digital dimensions, indicate in the facets of life which certain digital skills are related (Claassen, 2017).

The digital dimensions are as follows: digital literacy skills, user digital skills, ICT practitioner skills and e-leadership skills. Basic digital skills constitute the base level of understanding, followed by skills related to digital literacy, user skills, ICT practitioner skills and e – leadership skills. Digital literacy skills refer to individuals having a basic understanding of digital skills. While basic user skills constitute "generic or sector- or profession- specific" skills (Claassen, 2017:4). Basic ICT practitioner skills also known as "ICT Professional Skills" refers to the understanding of basic digital skills as related to ICT practitioners (Claassen, 2017:4). Finally, e – leadership constitutes the "digital leadership skills" (Claassen, 2017:4).

Figure 3 gives a detailed depiction of the different dimensions in which the digital skills are used. According to Figure 3, A. Digital Skills refers to individuals basic understanding and knowledge about electronic devices, applications, and digital devices (Claassen, 2017). For the purpose of this study digital literacy skills refer to "The ability of individuals to use digital tools and facilities to perform tasks, to solve problems, to communicate, to manage information, to collaborate, to create and share content and to build knowledge, in all areas of everyday life and for work" (Claassen, 2017:6). User digital skills should not be confused with

Sector user skills. User digital skills (B), which is a subset of digital literacy (A) refer to a more advanced level of skills regarding digital tools and devices. The digital skills in this area are "word processing, spreadsheets, presentation, web browsing and knowledge flows, project management, social media proficiency, cloud (understanding and usage), safety, security, privacy and backups, netiquette and ethics and collaboration in the digital context" (Claassen, 2017). While E. Sector user skills implies individuals' occupational responsibilities as they relate to a specific sector in industry (Claassen, 2017). In this area, digital skills mean comprehending different aspects of modern media, being able to work with information in different formats, comprehending the importance of copyright and digital platforms, having the necessary skills to implement various applications and combination of applications, having the ability to use technology creatively (Claassen, 2017). Component C. ICT – practitioner skills constitute technology specialists who should have research, development, system design, system management, digital marketing, integrating, testing, maintaining, and service support skills (Claassen, 2017). Finally, D. e-leadership skills refer to those digital skills held by individuals in leadership positions who need to be able to manage a business successfully in the 21st century. According to DSF1 managers, executives, and leaders need to demonstrate the capability "to ensure more effective performance of different types of organisations, to explore possibilities for new ways of conducting business and organisational processes, to establish new businesses, organisations, platforms and applications or interventions and to effect innovation" (Claassen, 2017).

As mentioned above, the DSF1 served as the foundation of the proposed digital skills development framework. The DSF1 is an appropriate framework for the study as it establishes the digital skills required by individuals to function optimally in today's digitally driven era. As a university transitions from a traditional campus community to a smart campus community, digital skills are required to function within the smart campus community. DSF1 establishes the digital skills required by students to function optimally within a smart campus community. The researcher theorises that as traditional communities follow the journey to transition to a smart campus community, certain challenges arise. These challenges can be solved in part by ensuring community members (students) are equipped with the necessary digital skills to solve the challenges. It is for this reason that the researchers determined exactly which digital skills solves which challenges. The online survey determined the connection between each individual challenge and the digital skills required to solve that challenge from the students' perspective. An analysis of DSF1 cross-referenced with the answers given by the students was the first

steppingstone to connect the digital skills in DSF1 to the challenges faced by universities as they transition from a traditional campus community to a smart campus community.

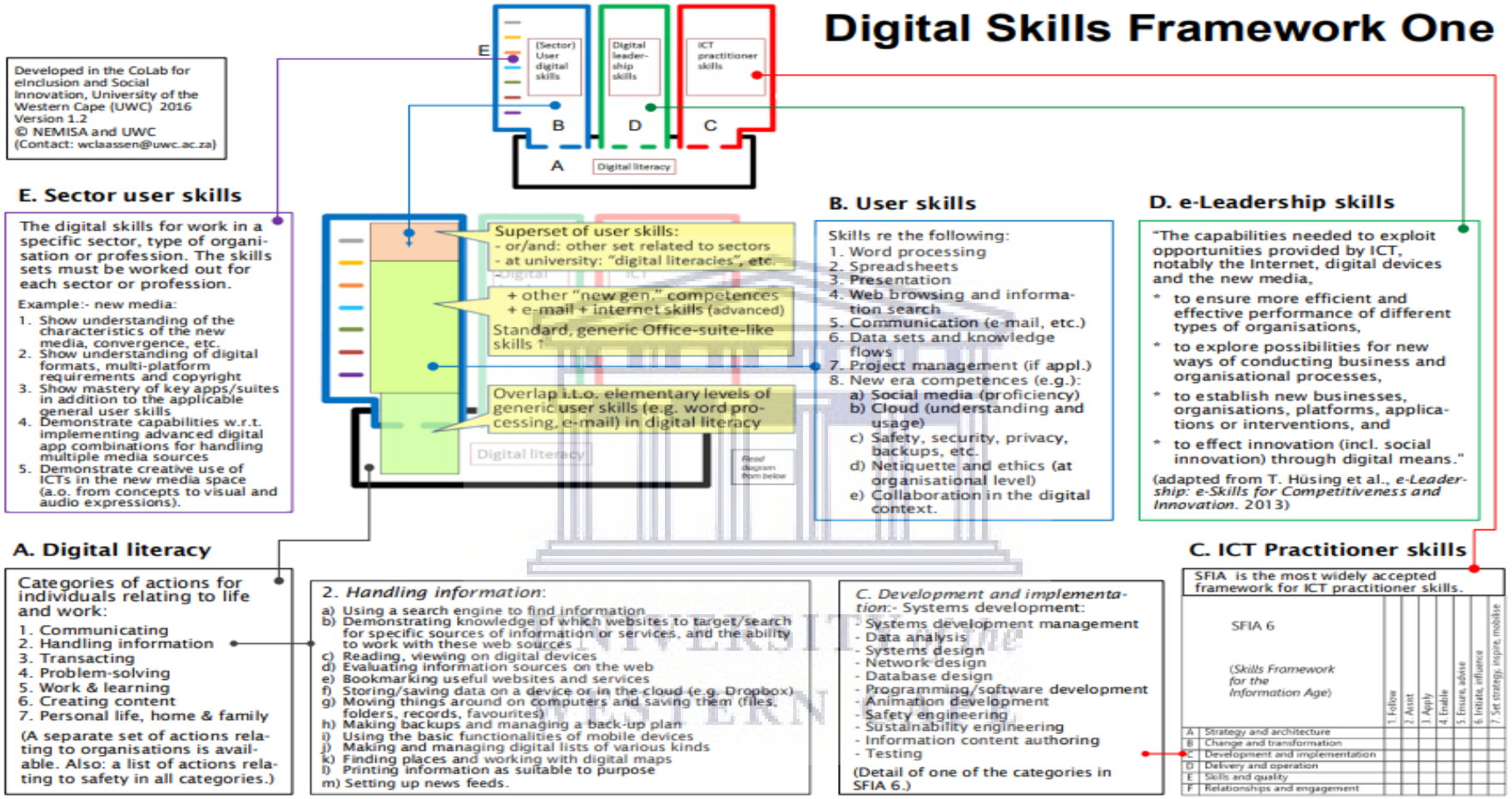


Figure 3: Digital Skills Framework (Source: Claassen, 2017:1)

2.6 Quadruple Helix

2.6.1 The advent of the quadruple helix

The university ecosystem is made up of various role-players. For the purpose of the study, the Quadruple Helix was used as a detailed and structured representation of the role-players involved in supplying digital skills to campus community members (students). Countries across the world are facing an increase in international rivalry and competitiveness (Carayannis & Campbell, 2011). A country that seeks to be competitive needs to stay ahead in terms of innovation. Thus, the idea of innovation has shifted from a closed industry phenomenon to stakeholder groups from various industries sharing a common goal (Carayannis & Campbell, 2011). The Quadruple Helix is a shift from the traditional top-down business structure, towards a user-centric and open innovation system (Arnkil, Järvensivu, Koski & Piirainen, 2010). The term Quadruple Helix is a revision and expansion of the previously known Triple Helix (Parveen, Senin & Umar, 2015). The Triple Helix was developed by Etzkowitz and Leydesdorff (2000), to describe the innovation network among policymakers/government, research institutions/universities, and industry/firms. Academics note that to create long-term value for innovation it is necessary to integrate culture and media to the innovation process (Kolehmainen, Irvine, Stewart, Karacsonyi, Szabó, Alarinta & Norberg, 2016; Galvão, Mascarenhas, Gouveia Rodrigues, Marques & Leal, 2017). Thus, stakeholders from different industries and backgrounds are added to the Quadruple Helix to ensure that contextual cultural, and media considerations are taken into account during the development of an innovation process (Kolehmainen et al., 2016; Galvão, Mascarenhas, Gouveia Rodrigues, Marques & Leal, 2017). In Arnkil et al. (2010) study, the researchers identified the key role-players and their fundamental responsibilities as seen in Figure 4 below. Key role-players in the Quadruple Helix are as follows: public sector, firms, civil society and universities. The aim of the Quadruple Helix is to allow communities to develop through the positive actions of various stakeholder groups in a network (Kolehmainen et al., 2016).

Figure 4 illustrates the different roles each sector is responsible for in the Quadruple Helix. Firstly, the public sector represents the policymakers or public authorities within society (Leigland, 1994). In a user-centric innovation process, the role of the public sector is as follows: support user innovation and offer a means of dialog between stakeholders. The firms constitute social entrepreneurs, local and international businesses, and enterprises willing to create unique products and services to benefit civil society (Martin & Osberg, 2007). The responsibilities of the business sector are as follows: to support the innovation process driven by citizens and

develop the products and services based on products and services identified by citizens. Civil society represents the users directly impacted by innovation. The users are responsible for designing and creating solutions based on citizen needs in the community. Lastly, the universities, the institution where academia use research and management skills to assist in the innovation process. Their responsibilities are as follows: to support all stakeholders and their roles within the Quadruple Helix.

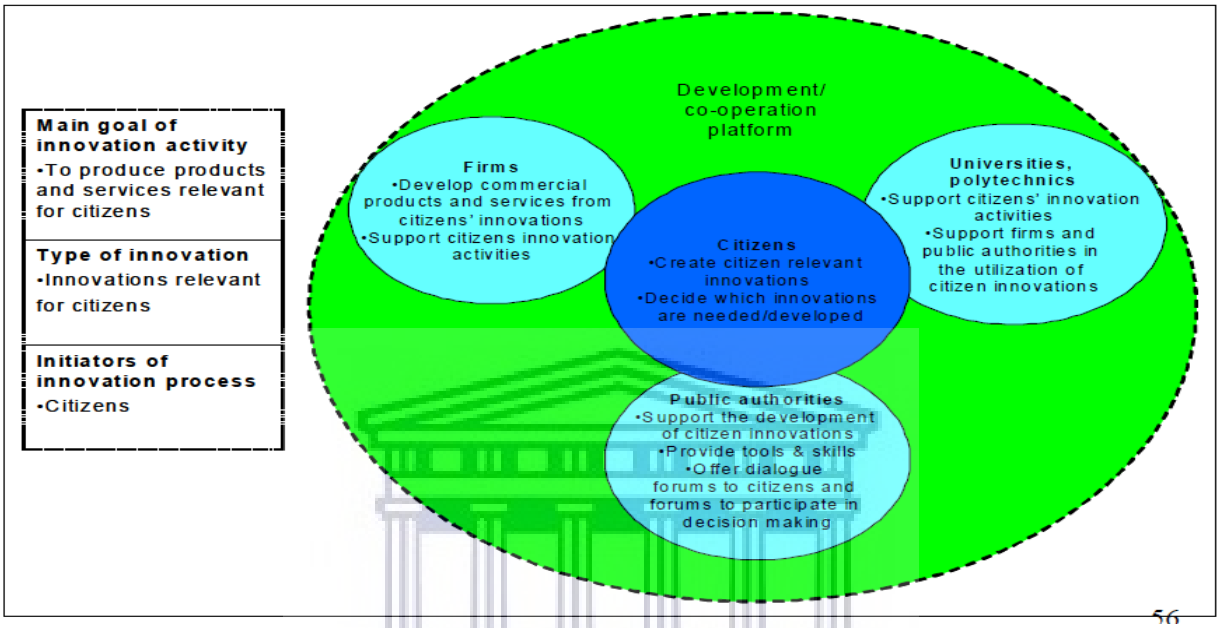


Figure 4: Citizen centred Quadruple helix model (Source: Martin & Osberg, 2007:56)

2.6.2 Challenges and considerations involving the quadruple helix

A variety of factors contribute to the challenges existing in the Quadruple Helix. Perkmann et al. (2013), mentioned several factors that contribute to the possibly strained relationship between university and industry. The factors stated in Perkmann et al. (2013:426), the study includes four core categories such as "Individual determinants", "Organisational determinants", "Institutional determinants" and "Impact" Individual determinants consisting of factors such as "age, seniority, previous commercial experience, grant awards (government), contract awards and scientific productivity" (Perkmann et al., 2013:426). Organisational determinants consist of "quality departments, organisational support, incentive systems, original commercial experience, and peer effects" (Perkmann et al., 2013:426). Institutional determinants consist of "applied discipline, bio science and country-specific regulations" (Perkmann et al., 2013:426). Lastly, the Impact represents "scientific productivity, commercial productivity, shift towards applied research, increased secrecy, collaborative behaviour and teaching" (Perkmann et al., 2013:426). Prominent criticism of the Quadruple Helix is that the addition of more stakeholders can result in troublesome networking relationships

predominantly caused by variation and inconsistencies in demands (Miller, McAdam & McAdam, 2018). Several authors suggested that there remains a need to manage stakeholder relationships to ensure that the visions set out by the different groups are accomplished (Hughes & Kitson, 2012, Arnkil et al., 2010, Miller et al., 2018). The efforts made by the members of the QH are often plagued by budgetary constraints, lack of understanding of technology being implemented, and the absence of clarity regarding stakeholder members collective goals (Borghys, van der Graaf, Walravens & Van Compernolle, 2020). Similar to Perkmann's (2013) study, Fitzpatrick and Malmborg (2018), recommended that in order for the QH to be effective, both individual and organisational cultures need to be taken into consideration. In addition, Fitzpatrick and Malmborg (2018), noted that defining collective goals, stipulation of a management approach, and encouraging consistent feedback from community members are also required. Albeit the challenges presented by this Helix, Carayannis and Campbell (2011), noted that the Quadruple Helix takes into consideration the culturally based and media-based spheres in a society which in turn promotes creativity to produce new sustainable and relevant innovations.

2.6.3 A lesson learnt from a multiple stakeholder approach

In the Fitzpatrick and Malmborg (2018) study, the authors detailed that a middle- out approach as the most appropriate approach to use in terms of leadership and management of the collaborative nature of a Quadruple Helix run project (Coeiera, 2009). To paraphrase Coiera (2009), the middle – out approach takes the strategies from both top -down and bottom- up approaches to effectively get a product to the market at the best time to the right people. In terms of the top – down approach, stakeholders can determine the gap within the market pertaining to technological advancement, while taking the needs of community members into account and building relationships by utilising strategies from the bottom-up approach (Coiera, 2009).

2.7 Higher education institution's role in the quadruple helix

The role of universities in society has changed and evolved based on the mode in which these institutions exist as part of the QH. Yun and Liu (2019), reflected on the Gibbons (1994) study, where *Mode 1* speaks of the *traditional role* of HEI which has mainly focused on academic performance and conducting research rather than having an emphasis on applying research (Saunders, Lewis & Thornhill, 2007). This mode receives much of its mandates from policymakers and state institutions (Salter & Martin, 2001). *Mode 2* represents the emphasis on technology transfer by means of research and development initiatives. This mode

encourages participation in conferences, partnerships between industry and other academic institutions, engagement in consulting practices, and to the publication of master's and PhD theses (Salter & Martin, 2001; Gibbons, 1994). Lastly, *Mode 3* refers to the collaboration between different stakeholder groups from various industries, engaging in non - linear management approaches towards reaching a common innovative goal (Perkmann & Walsh, 2007; Yun & Liu, 2019). As mentioned above, the Triple helix involves mainly, policymakers, industry, and universities, while the Quadruple Helix includes community members among the stakeholder groups.

Higher Education Institutions (HEI) play an important yet contradictory role in their development of their regional community. As stated by Kolehmainen et al., (2016), the role of a university is twofold, the first is to address the economic needs of a society by encouraging and developing a knowledge-based society to strengthen the economy of a country. The second, and quite simply more often, is to excel in global recognition for literary and academic contribution to the current body of knowledge, which can potentially result in loss of knowledge that should pertain to their own communities.

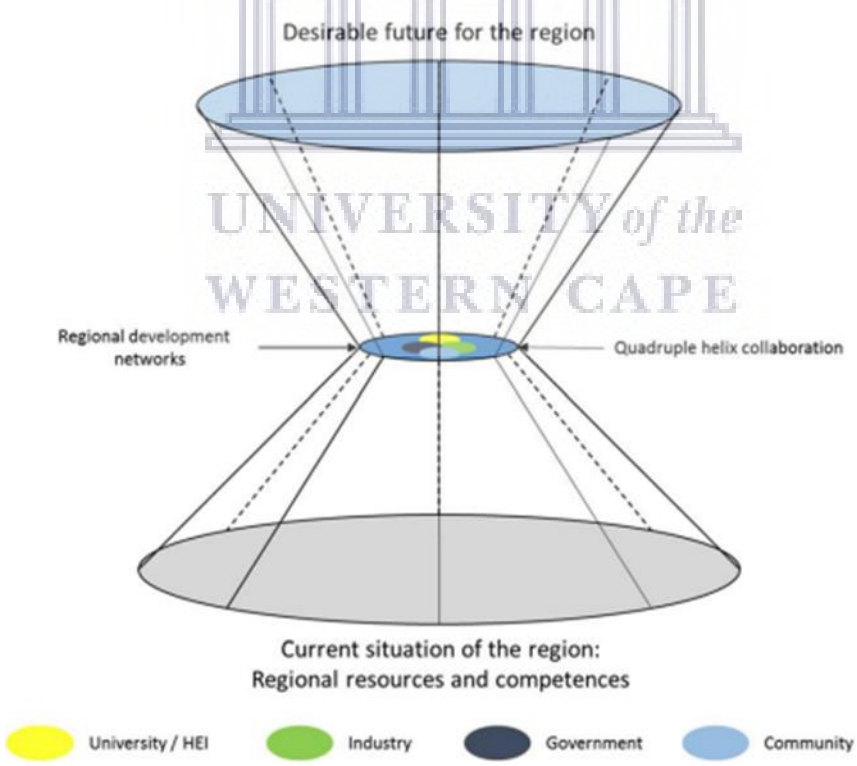


Figure 5: The Framework for knowledge - based regional development "Filling the black box" (Source: Kolehmainen, Irvine, Stewart, Karacsonyi, Szabó, Alarinta & Norberg, 2016:29)

The Framework for knowledge – based regional development created by Kolehmainen et al. (2016) positions the QH as a predominantly region or community-focused approach. The flow

of the approach is dictated by the importance of establishing the current situation within a community and thereafter with the assistance of the stakeholder groups to work towards a desirable vision for the community (Kolehmainen, 2016). The motivation to insert this model as a key resource within this study stemmed from the facts that the case study institution is in the process of transitioning from a traditional HE community to a desired smart campus community. In the process of transitioning certain stakeholders from different industries take part in the transformative innovation process. It was thus important for the researchers identify the stakeholders involved the innovation process to ensure that the necessary basic digital skills were supplied to the students.

2.8 Intermediaries as a stakeholder group

As mentioned above, the role of the QH stakeholder groups is to assess the current situation in which a university exists and work towards a common goal to create a smart campus environment. The well-known stakeholder groups are industry, government, community members and research institutions. However, the role which intermediaries play as part of an addition to the stakeholder groups is an opportunity missed in the current body of knowledge. E - Inclusion Intermediaries (E-IIs) can be defined as organizations that employ ICT infrastructure, developments, and advancement to aid and upskill members within a community (Katunga, Njenga, Craffert, Audenhove & Marien, 2019). Examples of intermediaries include internet cafes/hubs, digital hubs, public libraries, and innovation labs. According to Katunga et al. (2019), E-IIs exist within three modes. One mode is part of the public sector, delivering their services free of charge. The second mode is part of the 3rd sector, whereby the services rendered to community members are predominantly free of charge or subsidised through a government or private sector. The third mode in which E-IIs exist is as part of the private sector. In this mode, the E-IIs services are available for public consumption at a predetermined cost. The impact of the outcomes and the interventions of intermediaries within communities remains a critically under-researched area within the current body of knowledge. However, E-IIs presents an opportunity not only to provide access to technological infrastructure and devices and assist in but also assist to develop the basic digital literacy skills of community members.

The QH played a crucial role in the development of the proposed digital skills framework. Notedly, as the literature affirms, there is substantial benefit in allowing multiple stakeholder groups to provide a community and community members with their necessary improvements. The researcher has theorized that to solve challenges related to the transition from a traditional

campus to a smart campus community students' need to obtain relevant digital skills. However, the supply of these digital skills cannot be solely left in the hands of students. Therefore, the responsibility for supplying the necessary digital skills to students should be shared among stakeholder groups all geared towards a common goal. The goal, in terms of this study, would be to provide students with the necessary digital skills to function optimally and confidently within a smart campus community.

2.9 Chapter summary

The previous chapter presented a theoretical background related to this study. Additionally, key components including the research problem, objectives, and questions of this study were presented. Chapter 2 aimed to give a detailed account of the current body of knowledge pertaining to the key focus areas of the study. Smart city and community concepts were discussed to showcase the journey from a traditional to a smart community. Thereafter, smart campus community elements and their need for digital skills was discussed. Finally, the role which the Quadruple Helix plays within the innovation process of an HE community transitioning to a smart campus community was discussed. Table 6 represents the relationships between the key focus areas of the research. Firstly, the first column describes the challenges HE communities face when transitioning to a smart campus community. The second column identifies the necessary digital skills required to solve the challenges presented. The third column identifies who within the quadruple helix should be responsible for providing digital skills to students, together with references related to the current body of knowledge pertaining to the digital skills and stakeholders. The final column notes each online survey question asked as it relates to the challenges in the first column.

The following chapter will present the research process of this study. Primary attention will be given to the research philosophy, research choice, research design, sampling, instrument design, data analysis, and ethical considerations.

Table 6: Proposed digital skills development framework (pre- data collection)

Digital skills and stakeholder responsibilities summary					
No	**Challenges**	**Skills related to challenge from literature (DSF1)**	**Skills-stakeholder links from Quadruple Helix**	**Literature**	**Survey questions**
1	Access to digital devices	Problem solving Transacting Work and learning	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arnkil, Järvensivu, Koski & Piirainen (2010); Carayannis and Campbell (2011); Katunga, Njenga, Craffert, van Audenhove & Marien (2019), Kolehmainen, Irvine, Stewart, Karacsonyi, Szabó, Alarinta and Norberg (2016)	Please select the digital devices you have access to. (drop down list)
2	Access to internet connectivity	Transacting Problem solving	Universities Industry Intermediaries Government	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Do you have access to internet connectivity at your residential address?

No	Challenges	Skills related to challenge from literature (DSF1)	Skills-stakeholder links from Quadruple Helix	Literature	Survey questions
3	Digital skills	Communication and collaboration Managing information Transacting online Problem solving Work and learning Content creation Personal life Text processing Spreadsheets Presentation Web surfing	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	How would you rate your current basic digital literacy skills? How would you rate your user skills?
4	On and off - site mobility	Communication and collaboration Managing information Transacting online Problem solving Work and learning	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Do you agree that this is in fact a challenge students experience? Do you think optimization of on - campus digital services might benefit you and your peers? For example: implementing a parking assistance app If you stay far from campus, do you think you and your peers might benefit from an optimized system to either locate parking/find the nearest routes to classes on campus? What digital skills would you need to be a confident user of the system mentioned above?

No	Challenges	Skills related to challenge from literature (DSF1)	Skills-stakeholder links from Quadruple Helix	Literature	Survey questions
5	Physical safety of students	Communication Problem solving	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Have you ever felt unsafe walking or driving alone on campus? Do you think that physical safety on campus is a challenge students experience? What assistance would have helped you to feel safer on campus? Do you think we could use technological advancements to solve this challenge? For example: a campus safety app What digital skills would you require to use the safety application?
6	Data privacy	Online etiquette Managing information Transacting Problem-solving Personal life	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Are you ever concerned using your personal data online? (For example: Using your ID number to access your student email account) Do you think the use of personal data on online platforms is a challenge students experience? What would make you feel at ease when using your personal data online? Do you think we could use technological advancements to solve this challenge? For example: Making use of a Virtual Private Network (VPN) to safeguard personal information What digital skills would you need to confidently use the technology mentioned above?

No	Challenges	Skills related to challenge from literature (DSF1)	Skills-stakeholder links from Quadruple Helix	Literature	Survey questions
7	Student administration	Online etiquette Managing information Transacting Problem-solving Personal life	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Do you find it challenging to complete administrative tasks via online services? Trouble changing modules online/trouble receiving programme advice online/making payments. Do you think that this is in fact a challenge students experience? What would have helped you to complete administrative tasks online? Do you think we could use technological advancements to solve this challenge? What digital skills would you require to deal with your personal online administrative tasks?
8	Teaching and Learning initiatives	Communication and collaboration Managing information Transacting online Problem solving Work and learning Content creation Personal life Text processing Spreadsheets Presentation Web surfing	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Have you ever struggled to attend face-to-face classes, or online classes? Do you agree that this is in fact a challenge students' experience on campus or online? What assistance would have helped you to improve your class attendance? Do you think this challenge can be solved by using technological advancements? What digital skills would you as a student require to engage confidently on an e-learning platform?

No	Challenges	Skills related to challenge from literature (DSF1)	Skills-stakeholder links from Quadruple Helix	Literature	Survey questions
9	iKamva (LMS)	Communication and collaboration Managing information Transacting online Problem solving Work and learning Content creation Personal life Text processing Spreadsheets Presentation Web surfing	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Have you ever struggled to use iKamva? Do you agree that this is in fact a challenge students experience? If yes, what are the challenges you and your peers experience with iKamva? Do you think this challenge can be solved by means of technological solutions? If UWC were to update iKmava to suit your needs as a student, what digital skills would you require to be a confident user of this platform?
10	Lack of innovative spaces	Communication and collaboration Managing information Transacting online Problem solving Work and learning Content creation Personal life Text processing Spreadsheets Presentation Web surfing	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Do you think UWC lacks innovative/creative study areas? Do you think that this is in fact a challenge students' experience on-campus? What would have wanted innovative/creative study areas to include? For example: Interactive white boards (other technologies?) Do you think we could use technological advancements to solve this challenge? What digital skills would you need to use technological advancements in the innovative study areas?

No	Challenges	Skills related to challenge from literature (DSF1)	Skills-stakeholder links from Quadruple Helix	Literature	Survey questions
11	Health and Wellness	Managing information Transacting Problem-solving Personal life	Universities Industry Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	In terms of your health and wellness, do you have any concerns returning to campus post -pandemic? Do you think that this is in fact a challenge some students experience? In terms of your health and wellness, what procedures/processes/technology would make you feel comfortable to return to campus? Do you think we could use technological advancements to solve this challenge? For example: An application to monitor the spread of the virus on campus. What digital skills would you need to confidently use the app required to monitor the spread of the virus?
12	Food security	Managing information Transacting Problem-solving Personal life	Universities Industry Intermediaries Government	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Have you ever experienced any challenges related to food on campus? For example: Restaurants closing due to the pandemic/ lack of nutritional food on campus/food scarcity. Do you think that this is in fact a challenge students' experience on campus? What would have helped you to find the various food services on campus? Do you think this challenge can be solved using technological advancements? For example: Community Garden powered by solar power and smart gardening equipment/ an app to show restaurant location, price lists, and availability. What digital skill would you require to confidently use smart gardening equipment or food security apps?

No	Challenges	Skills related to challenge from literature (DSF1)	Skills-stakeholder links from Quadruple Helix	Literature	Survey questions
13	Sustainability	Communication and collaboration Managing information Transacting online Problem solving Work and learning Content creation Personal life Text processing Spreadsheets Presentation Web surfing	Universities Industry Intermediaries Government	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	Would you accept facial recognition systems to monitor movement and class attendance on campus? Please elaborate as to why you would/would not accept facial recognition systems on campus. Are there any specific technologies you would like to see and use on campus? For example: interactive whiteboard.

Chapter 3: Research methodology

3.1 Introduction

Chapter 2 highlighted the existing knowledge pertaining to the key focus areas of the study. The study aimed to design a proposed digital skills development framework towards equipping community members with the necessary digital skills to function productively in a smart campus community. Chapter 2 further discussed the journey of traditional campuses as they transition to smart campus communities, delineated the challenges of smart campus communities, outlined the digital skills necessary to resolve the smart campus challenges, and discussed the role of the quadruple helix as a way to supply the digital skills to members of a smart campus community.

The following chapter presents the plan of action pertaining to the research process. The methodology is an essential part of the research process (Al Kilani & Kobziev, 2016). The purpose of a methodology is to establish a set plan based on distinct stages to ultimately resolve the research problem (Davis & Yen, 2019). Chapter 3 encompasses the 'research onion' to establish the stages of the research process within the study (Saunders, Lewis & Thornhill, 2019), and will clarify the research philosophy, approach, strategy, time horizons, techniques and procedures of the study. Additionally, key considerations involving the validity and reliability of the study will be stipulated to clarify how research quality and standards were upheld during the research process.

3.2 Research Philosophy

The research philosophy can be defined as "a system of beliefs and assumptions about the development of knowledge" (Saunders et al., 2019). A researcher is certain to make assumptions about their research whether they are deliberately aware of this or not (Burrell and Morgan, 2005). Thus, the researcher's assumptions must be well researched, valid, and reliable to ultimately generate an accurate research philosophy (Saunders, Lewis & Thornhill, 2019). The philosophical discourse which is interpretive in nature gave precedence to this study. According to Klein and Myers (2001), interpretivism is based on the theory that an individual's comprehension of world events is based on environmental influence and factors such as objects, images, records, shared interest, languages, and cognitive awareness. Similarly, Saunders et al. (2019), stated interpretivism theorise that humans are different from other life forms because humans have the ability to create meaning. The meaning that is created is then analysed by interpretivists. Thus, the purpose of interpretivism is to recognize and comprehend

the unique perception of humans based on the context or phenomena they are exposed to (Saunders et al., 2019). In terms of this study, the researcher has gathered primary data from participants to determine what their unique perception is regarding their need for digital skills in a technologically transitioning campus environment. The researcher aimed to interpret and analyse these perceptions to adjust the proposed framework as per the feedback from the participants.

3.3 Information Systems

Information Systems (IS), in the light of all academic disciplines is but a relatively new field of study (McArthur & Vithal, 2017). The advent of the discipline comes with definitional challenges as researchers and industry struggle to generate an all-encompassing definition (Westerfall, 2019). For the purpose of this study, the definition is as follows, Information Systems can be defined as the combination and amalgamation of hardware, software, human interaction, and interfaces, geared towards solving a challenge through innovative and creative ideas (Hevner, March, Park & Ram, 2004; Hevner & Chatterjee, 2010). Authors in the field of IS have stated that Information Systems was established to improve and sustain the productivity and systematic operations within an organization by means of incorporating a methodological approach (Silver, Markus & Beath, 1995; Hevner et al., 2004). IS has several methodological approaches and principles to guide the research process (Baskerville & Myers, 2015; Davis & Yen, 2019; Baskerville, Baiyere, Gregor, Hevner & Rossi, 2018). A design science approach can be defined as the practice of adding to the current body of knowledge pertaining to design in a convenient and attainable format (Gregor, Kruse & Seidel, 2020), typically adding design principles to existing design processes. The following section elaborates on the various design principles used in Information Systems research.

3.3.1 Design science research

Systems design or design science research (DSR) has historically been determined as electronic, scientific, and technological in nature (Lienig & Bruemmer, 2017). Traditionally, disciplines synonymous with the use of system design have been predominantly engineering, medical, and computer science (Peffers, Tuunanen, Rothenberger & Chatterjee, 2007; Gregor et al., 2020). In recent years, several attempts have been made to incorporate systems design into Information Systems research and applications (Peffers et al., 2007; Gregor, 2020; Pascal & Renaud, 2020). As a result, the term Information Systems Design Science Research (ISDSR) has been established to recognise the role systems design plays in Information Systems (Schuster, Wagner, Schryen, 2018; Pascal & Renaud, 2020). Systems design can be defined as

a meticulous process of designing and creating artifacts, to conduct research upon scientific observations, to contribute to the current body of knowledge and ultimately inform end-users of the research conducted (Hevner, March, Park & Ram, 2004). A popular way to manage the design and creation of a new system is through the assistance of the Systems Development Life Cycle (SDLC). The SDLC is defined as a detailed plan of action that serves as a design methodology (Davis & Yen, 2019). Common systems design methodologies include Waterfall model, Agile model, Spiral model, Design Thinking and Agile design (Balaji & Murugaiyan, 2012; Alshamrani & Bahattab, 2015; Davis & Yen, 2019). In terms of this study, the systems design approach seems to have the advantage of incorporating technology and ID grounding to the study however, it lacks some nuanced emphasis on open innovation between researchers and end - users.

3.3.2 Design based research

Design based research (DBR) refers to the best practices and processes used to create innovative ideas, solutions, hypotheses and artifacts (Barab & Squire, 2004). As stated in Chapter 2, HE communities are experiencing an array of challenges. These challenges range from, global competition, the retirement of the Baby Boomer generation, socio-economic issues, to the increased demand for a specialised skilled workforce (Bradley, Noonan, Nugent, & Scales, 2008). Design based research is a powerful approach within research that can be used to address HE community related challenges (Herrington & Reeves, 2011). The manner in which DBR addresses the challenges is by involving and encouraging the collaboration between researchers and participants (Wang & Hannafin, 2005). Another advantage is that since DBR encourages collaboration between researchers and participants, the design approach is useful for studies requiring contextual data (Wang & Hannafin, 2005). However, the approach is still in its infancy and neglects to emphasize scientific validity based on statistical or laboratorial data (Wang & Hannafin, 2005). As stated by Wang and Hannafin (2005) the lack of scientific data could cause the results to be considered questionable or less valid by policymakers. When considered for use in this study the DBR has the advantage of promoting collaboration between researchers and participants, however the approach currently lacks emphasis on technical and statistical approaches to successfully collect data of a technical nature in the study.

3.3.3 Ethnographic research

The ethnography approach has been defined as a research design method dictated by observing subjects without any participation from the researchers (Baskerville & Myers, 2015). Saunders

et al. (2019), have stipulated that ethnography is one of the most traditional approaches to research and is inherently utilised "to study the culture or social world of a group". A more modern approach to ethnography, commonly known as ethnographic design is characterised by the participation of researchers, from playing a purely observational role to an active role within the gathering of data (Baskerville & Myers, 2015). However, much of the researcher's involvement is substantially limitless and, in some cases, fruitless (Sanders et al., 2019). A possible disadvantage of ethnographic research is the emphasis on predominantly qualitative data and is a nontechnical approach to collect data relying mostly on an observational collection method (Saunders et al., 2019). In terms of its potential use in this study ethnographic design lacked the ability to incorporate quantitative data and to analyse data of a technical nature.

The appropriate research design for this study is the Living Labs methodology as it incorporates the desirable components of all three mentioned approached: the design of artifacts and/or processes, qualitative and quantitative data usage, and the active participation of the researcher in the study.

3.3.4 Living labs methodology

The authors of this study adopted a Living Labs (LL) methodology. The study aimed to create a conceptual digital skills framework by incorporating participants' feedback (online survey) into the innovation process. Living Labs is a well-known methodology that incorporates end users within the innovation process to achieve value for individuals and organizations (Schumacher & Feurstein, 2007). Guzmán, del Carpio, Colomo Palacios and de Diego (2013:29), defined Living Labs methodology as "innovation infrastructure within which software companies and research organizations collaborate with lead users and early adopters in creating participative strategies to define, design, develop, and validate new products and services that maximize the socio-economic conditions of the partnership". The user-centric approach involves incorporating end users in the early stages of the innovation process (Schaffers, Cordoba, Hongisto, Kallai, Merz & Van Rensburg, 2007). "The integration of users and other stakeholders into development projects has proved to reduce business risks such as the invention and acceptance of product services and applications" (Schumacher & Feurstein, 2007:1). The integration of end users and researchers into the Living Labs methodology relies on four critical stages namely "conceptualisation, concretization, implementation and feedback" (Schuurman, De Marez & Ballon, 2016). Although incorporating end users in the innovation process has advantages, some difficulties do exist (Schumacher & Feurstein, 2007). One criticism of the Living Labs methodology is the fact that it has no concise guidelines as to

how to construct and implement the model (Schaffers et al., 2007; Schuurman, 2015). Schuurman (2015), further stated that Living Labs has broad guidelines, approaches and goals. In order to ensure the success of the methodology, it requires infrastructure, software and experienced and dedicated participants (Guzmán et al., 2013).

There has been an emerging trend to use the LL methodology as a means to solve the challenges caused by the influx of people into urban communities (Voytenko, McCormick, Evans & Schliwa, 2016). A well-known approach of Living Labs methodology is the Urban Living Labs created by JPI Urban Europe (Brink, 2018). The Urban Living Labs methodology can be defined as an innovation hub that assists in the design, development, production, and implementation of new digital technology and systems by involving different stakeholders to co-design and co-create solutions in an urban environment (Brink, 2018). Some of their initiatives include Green Blue Cities, SmartGov, Smarterlabs, LOOPER and Smart Pedestrian Net. These initiatives support open innovation and take a user-centric approach to solve community challenges (Urban Europe, n.d). Another leader in the use of the Living Labs methodology is the European Network of Living Labs (ENoLL), which is an international organisation specialising in user-centric and open innovation to solve pertinent challenges in cities and communities. Thus, making use of a tried and tested model that can allow researchers to fully incorporate the end-users in the design process. ENoLL currently has 120+ members ranging from European companies to international partners. Their projects include My neighbourhood, City SDK, Design for Europe and Jam Today.

The LL methodology was appropriate for this study as it has a strong focus on end users and has the ability to allow for artifact/process design and quantitative data collection techniques. The LL methodology aligns well with Information Systems research and the established research principles as it incorporates and allows the researcher to engage with community members to solve community-related challenges. Hence, the Living Labs design was an appropriate approach to take for this study as it allowed participants to form part of the design process of the proposed digital skills development framework. The Living Labs methodology gave the researcher opportunity to take the key advantages of each of the design approaches mentioned above and incorporate those within this study.

The Living Lab conducted in the study followed the following process (Pierson & Lievens, 2005):

Contextualization. This is the explorative phase of the Living Lab. In this phase the researcher established the theoretic basis of the study to determine and identify the research framework and suitable participants within the study. Thorough research was conducted concerning the possible collection data methods and selecting the suitable method, which was in this case was an online survey. After which, the selection of the participants took place. More detail about the selection and sampling process can be located in Section 3.4.5.

Concretization. Once the appropriate candidates were selected as per the selection criteria (see section 3.4.5), the researchers conducted research regarding the challenges related to smart city developments were gathered by consulting the current body of knowledge. In the researchers Honours year, data was collected concerning students' perception and insights into the challenges they have experienced studying, living and participating in a campus transitioning to a smart campus community. These challenges in addition to the presented in current research formed the basis of the online survey. Please see Section 3.4.5 for more information related to the data collection method.

Implementation. A pilot test took place before the online survey was officially distributed to 15 participants. The test run was implemented to affirm that the questions were easy to comprehend, had no offensive terminology and was a sensible flow. For more information regarding the pilot test please see Section 3.4.5. Thereafter, the online survey was distributed to 15 participants as part of iteration 1. Iteration 2 followed during Covid. For more Information related to the time zones of the study, please see Section 3.4.4.

Feedback. After receiving the results of the 2 iterations the researcher began the process of interpreting the answers to give meaningful insights of the role in which digital skills are perceived by students at UWC. Finally, the researcher could create the final framework and establish recommendations for future research.

3.4 The 'research onion' method

The research process of this study can be described by means of Saunders et al. (2019), 'research onion' method. The 'research onion' method is a guide designed to assist the researcher during the research process (Saunders, Lewis and Thornhill, 2007). The research process is described by Saunders et al. (2019), as a non-linear process in which stages of a research project can overlap. Thus, the 'research onion' method seeks to organise the stages within a research process in such a way that they appear to be a linear process (Saunders et al., 2019). The shape of Figure 6 is reminiscent of an onion, where each layer depicts a different

stage within the research process. The following section will define and describe each of the research stages within the study.

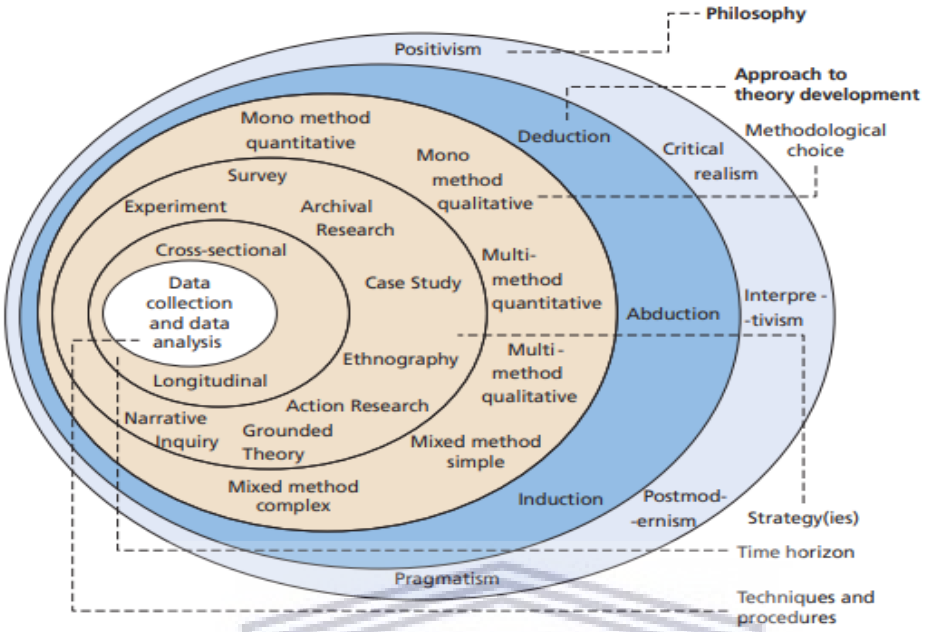


Figure 6: The research onion (Source: Saunders, Lewis and Thornhill, 2019:130)

3.4.1 Approach to theory development

The approach to theory development is a critical stage within the research process as it determines whether the researcher will either test or develop a new theory (Saunders et al., 2019). A deductive approach was followed within this study. A deductive approach can be defined as the development of a concept, framework, or theory based on an existing theoretical position (Thornhill et al., 2019). The deductive approach was necessary given that the study used the Digital Skills Framework (DSF1) to verify the digital skills participants currently possess and to determine the digital skills the students require to function productively in a smart campus community. The insights generated from the respondents were added to the proposed digital skills framework.

3.4.2 Methodological choice

The methodological choice refers to determining whether a study is a qualitative and/or quantitative study. Quantitative research methods can be defined as the use of surveys, charts, or statistical data to generate numerical data (Saunders et al., 2019). Qualitative research methods are described as the analysis of meaning and perception pertaining to participants' conceptualisation of a phenomenon (Saunders et al., 2019). This study made use of mixed methods which is an integration of quantitative and qualitative research methods (Saunders, Peter & Thornhill, 2019). The use of mixed methods offered the researcher an opportunity to

generate a diverse set of opinions and perceptions to ascertain unique insights into various aspects of the proposed framework based on data gathered from the online survey. Similarly, Venkatesh, Brown and Bala (2013), argue that mixed methods in Information Systems can generate insightful data stemming from the analysis of a phenomenon, which cannot be achieved by purely implementing either quantitative or qualitative methods. The specific mixed – method approach used in the study was concurrent triangulation design. This purpose of the design is to triangulate two different sets of data in order to validate the findings (Mengshoel, 2012). The concurrent triangulation design gave the researcher the opportunity to place equal importance and prioritize both the quantitative and qualitative data. Mixed methods gave the researcher a range of rich data to analyse, interpret from which to generate valid generalisations.

3.4.3 Research strategy

Research strategy refers to the proposed plan on how the researchers intend to answer the research question (Saunders et al., 2019). Research design can be defined as the plan of action to guide, control and conduct research (Mouton, 2001). The strategy the study incorporated was an exploratory research design in conjunction with a case study strategy. Exploratory research can be described as an inquiry or study related to fields in research that have yet to be thoroughly investigated (Blanche et al., 2006). With the purpose of gaining new insights into an event, phenomenon, or subject (Blanche et al., 2006). Common characteristics that describe this type of research is a high degree of flexibility and its ability to prove void of any known formal structure (Blanche et al., 2006). An exploratory research method was an appropriate approach on the grounds that the researchers will be analysing participants' insights into their perceptions about the digital skills they require to function optimally in a smart campus community. A case study can be defined as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context" (Robson, 2002:178). A single case was drawn from The University of the Western Cape. A single case can be defined as a unique phenomenon or original occurrence being investigated (Saunders et al., 2007). This study reflected on one phenomenon currently taking place at The University of the Western Cape. This phenomenon is the experience of a student in a traditional university transitioning to a smart campus community.

The choice of case study was determined by the studies focus on Higher Education Institutions. UWC is a community which encapsulates a large number of members stemming from diverse socio-economic backgrounds. Aligning exploratory research with the case study research

strategy gave the author the opportunity to gain rich insights and findings towards developing a digital skills development framework.

3.4.4 Time horizons

The time horizons describe the period of time in which data will be conducted (Saunders et al., 2019). In terms of this study, the researcher selected a cross-sectional approach. A cross-sectional study refers to examining a phenomenon at a specific point in time (Saunders et al., 2019). This study examined the participants perception about the digital skills required to function optimally in a smart campus environment. Thus, the researcher collected the perceptions of the students at this point in time.

The first iteration of the online survey was conducted pre-COVID-19 pandemic. The second iteration of the online survey was distributed to the same group of participants during the COVID-19 pandemic.

3.4.5 Techniques and procedures

Sampling

The study made use of a nonprobability sampling method. Non – probability sampling is often used to generate insights by means of in-depth qualitative research (Terre Blanche & Durrheim, 1999). Purposive sampling was used to select the participants for the online survey. Purposive sampling refers to an intentional selection of specific participants due to their knowledge, experience and insights (Etikan, Musa & Alkassim, 2016). The sampling method was an appropriate course of action due to the fact that a specific group of participants was required to complete the online survey. 15 students were purposively selected. The group of participants were a mixture of undergraduate and postgraduate students, all stemming from a commerce field. The participants possessed valuable insights and knowledge about the use of digital skills to solve campus challenges. Additionally, the researcher placed online post on Whatsapp and Instagram to encourage and invite UWC students who were willing to complete the online survey. Once the people responded to the posts, the researcher had to verify whether the prospective participants were eligible to form part of the study. Eligibility was determined by whether the prospective participant was in fact a student or alumni of UWC. In addition, researcher contacted lecturers within the Information Systems department to distribute the survey to their students. Furthermore, due to their area of expertise, the study maintains that the individuals chosen possessed the necessary knowledge to determine the digital skills students require to function optimally within a smart campus community.

Data collection

Primary data was sourced from the feedback of participants through the iterative distribution of an online survey. Primary data refers to the collection of empirical data (Saunders et al., 2019). Since the study adopted a Living Labs methodology, the feedback and insights generated by the participants during the two iterations were the main contribution of the study – a proposed skills development framework.

An online survey is the research instrument used to gather primary data from participants. Online surveys can be defined as research instruments used to collect quantitative data with the advantage of generating descriptive statistical data (Saunders et al., 2019). The researchers followed a research guide designed by Briggs (2015). According to Briggs (2015), a successful survey is based on the answers researchers wants to ascertain from their respondents. It was thus important for the researchers to conduct an exercise where they critically looked at the possible answers they wanted, and from that point onwards, created the questions.

The questions mentioned in the online survey were a combination of open - ended and closed ended to gain insights and knowledge from the participants. Open – ended questions can be defined as a technique that gives participants the opportunity to respond the questions in their own words (Reja, Manfreda, Hlebec & Vehovar, 2003). Hence, the use of open-ended questions served as a valuable technique to collect data on the sentiments of participants. The use of closed ended questions served as the quantitative technique to gather numerical data from the participants. The online survey included categorical questions. The categorical type questions include in the online survey were *yes/no* and *multiple-choice* questions. Additionally, ratio questions were included to gain insight as to the digital skills the respondents currently possess. A 7- point Likert-style rating was incorporated to gain rich insights from the respondents. The Likert -style rating is a measure used to as respondents how strongly the agree or disagree with a specific statement, phenomena, or situation (Saunders, et al., 2019). According to Joshi, Kale, Chandel and Pal (2015), a 7-point Likert scale can prove to be more advantageous and reliable than a 5-point Likert scale. The qualitative questions presented to the participants were open-ended questions. These questions were incorporated in the online survey to give the participants the opportunity to share their opinions and perceptions about a phenomenon in their own words. This instrument was suitable due to the fact that the researcher

had to gain individual insights from participants pertaining to their perception about the digital skills the participants possess and the digital they think is necessary to function productively in a smart HE community.

The study followed a cross-sectional research approach whereby two iterations of the distribution of the online survey were conducted. Firstly, a pilot test was issued to 4 participants. The purpose of the pilot test was to confirm that there were no bias, discriminatory, vague or unnecessary questions directed at the respondents (Saunders et al., 2019). The results of the pilot test confirmed that the questions had a logical flow and were easy to comprehend, the scale of the sample was appropriate, and the protocols following the online survey in Google Form were acceptable. Thereafter, the link to the online survey with clear instructions were sent to the group of participants. The distribution of the online survey via email took place before COVID-19 pandemic.

Once feedback was generated, the research could proceed to distribute the amended online survey to the same group for the second time. The second iteration occurred during the pandemic. The initial iteration was to establish the challenges students currently experienced in an HE community. While the second iteration involved collecting the opinions of participants related to their understanding of the digital skills necessary to function within a smart campus community. The feedback and insights of the participants after the second iteration ensured that all the digital skills identified during the pandemic were verified and recorded in the proposed framework.

Design and allocation of codes

Designing the codes related to each challenge were established by the researcher from the perception gained from the background information of the study, the current body of knowledge related to the main idea within the study, and the answers given by the respondents. All the qualitative and quantitative data collected during the online survey were analysed to ensure that the proper codes were assigned in order to relate back to the research question and objectives.

The process to code the qualitative research data was as follow:

- The researcher based the initial codes on the challenges identified in previous research. Each HE community-based challenges were assigned a code to reflect the type of challenge it is. For a summary of the challenges, please refer to Section 2.3.

- Thereafter, the solutions presented by the researcher and the respondents to solve the challenge were coded to ensure that each solution was transcribed.
- Finally, the digital skills related to each HE community-based challenge was coded by making use of the DSF1 and the additional digital skills identified by the participants.
- Definitions were assigned to each code to ensure that the qualitative data was linked to the correct code.
- 15 participants contributed to the study that included two iterations. Iteration 1 involved questions pre-COVID-19 and the respondents answered the second set of questions during the pandemic. The additional questions were assigned new codes which followed the same procedure as the rest of the codes.
- The categories for the codes were predetermined as the challenges pre-emptively linked to each category based on the Deloitte (2015), model.

The process of coding quantitative data:

- The data collected from the Google Form (online survey) was saved and stored in Excel.
- Examined the data collected and established broad categories.
- Thereafter, each of the questions related to a challenge was categorised based on the Deloitte smart community phases (Deloitte, 2015).
- The answers to the questions were assigned a code to as it related to a specific challenge.

The process of data entry and checking (Saunders et al., 2019)

- The layout and the format of the data collected from the participants met the requirements of the analysis software.
- The data, once entered, the software was saved, and a back-up copy was made.
- The data was checked for errors, none were found.

Researchers' role in the study

The researchers comprehend that by following an interpretive approach, using online surveys under the guise of a Living Labs methodology, demands an active researcher role. The active participation of researchers has been demonstrated with success in Klein and Myers (2001) study. The researcher affirms that the answer to the research question resides with the perceptions of the participants (Klein and Myers, 2001). Therefore, it was important for the

researcher to involve herself and himself in the iterative process to obtain rich insights from the participants. Thereafter, it was the responsibility of the researchers to interpret the perceptions of the students. The researchers were therefore instrumental in generating the online survey, guiding participants through the two iterations and ensuring the participants understand the questions presented to them. Finally, after the second iteration, the researchers finalized the proposed framework based on her interpretation of the participants insights and concluded with her findings, discussion, conclusion, recommendations, and limitations of the study.

3.4.6 Delineation

The present study was conducted at the University of the Western Cape (UWC), situated in the city of Cape Town, in South Africa. A total of 20 500 work and study at the case study university (University of the Western Cape, 2020). UWC proved to be a proper geographical location from which the researchers could conduct the study for the following reasons, the convenience of the location, the researcher's familiarity with the characteristics of the population, and the convenience of purposively selecting participants from a pool of students. The study aimed to create a proposed digital skills development framework that depicts the digital skills necessary for students to function optimally in a HE community transitioning from a traditional HE community to a smart campus environment.

The sample of the study was limited to 15 students. The scope of this study was limited to only delineating the basic digital skills of current and former UWC students that completed or are in the process of completing their respective degrees. The study focussed primarily on the basic digital skills students need to function optimally in a smart campus environment. Thus, the study did not specify the advanced or specialised digital skills students need to operate and manage technological advancements in a smart HE community. These students included undergraduate students in pursuit of a degree in Commerce and Post-graduate students all stemming from a field in Commerce. Since the study adopted a Living Labs methodology, the first iteration of the online survey (Google Form) was issued pre-pandemic. The second iteration of the online survey was issued during the pandemic.

3.4.7 Data analysis and storage

The study incorporated both quantitative and qualitative data, based on the mixed - methods approach. The quantitative data was analysed using a descriptive statistical approach. This descriptive analysis approach can be defined as a synopsis of the data gathered in the data

collection process in order to ensure that the findings are understandable for the researcher and the reader (Finlay & Agresti, 1986). Content analysis was incorporated to evaluate the data collected. Content analysis can be defined as measure of analysis to code and group visual, text and audio data collected through quantitative data collection methods (Saunders et al., 2019). The analysis tool was incorporated to code and categorise the quantitative data collected from the online surveys.

The primary data collected was analysed by using Atlas.ti version 9 and Microsoft Excel. Atlas.ti is a computer program that facilitates the analysis of qualitative data. The program was used to analyse, manage, and store the qualitative feedback generated from the online surveys. The program served as a beneficial tool to store, manage, arrange, and interpret primary data collected from the participants. Microsoft Excel is "a software program created by Microsoft that uses spreadsheets to organize numbers and data with formulas and functions" (Corporate Finance Institute, 2020). The powerful software has the ability to analyse, arrange and manage text, numbers and data (Corporate Finance Institute, 2020). The online survey was distributed using Google Forms, which allows participant answers to be downloaded as Microsoft Excel files. Thereafter, the qualitative feedback was uploaded to Atlas.ti. While the quantitative data was recorded on Microsoft Excel. Excel has unique capabilities and formulas built into the programme that helped arrange the data. Additionally, the dashboard function allowed the researcher to create a clear presentation of the qualitative data in an organised manner. The insights of each participant were documented by category on Excel. The research material was stored on the researchers' university Google Drive. The researcher will discard any electronic personal information after 2 years. The process of disposing the research material will be according to the prescribed method and approach as per the Protection of Personal Information Act 4 2013.

3.5 Measures to establish validity and reliability of the study

3.5.1 Validity of the mixed methods approach

Validity and reliability are critical components within the research process as they establish the quality of the research conducted (Saunders et al., 2019). Validity refers to effectiveness of the measurement used and the extent to which the data analysed, findings and generalizations made were correct (Saunders et al., 2019). In order to establish validity in the study, certain aspects need to be taken into consideration. Firstly, internal validity, otherwise known as measurement validity, was established. In relation to this study, internal validity refers to the capability of online survey questions to measure exactly what the researchers intend to measure. As stated

by Saunders et al. (2019), internal validity is directly correlated with the structure and purpose of the questions asked during data collection practices. The researchers implemented a participatory and collaborating mode of research. According to Zohrabi (2013), conducting a study on your own is a challenging endeavour. Thus, this mode of research allowed the researchers to include numerous individuals in specific phases of the research process to strengthen the validity of the research instrument and the interpretations of the research findings (Zohrabi, 2013). For example, before the research instrument was created, the researcher collaborated with two doctorate alumni specialising in the field of Information Systems, to gather their insights into the type of instrument the researcher should use, the manner in which the journey from a traditional campus to a smart campus community should be presented and the questions the researcher should be presented to the participants. The two Doctors were then asked to assess the online survey to establish whether the questions asked were accurate, unbiased and valuable to the research being conducted.

The second aspect, content validity, constitutes the ability of each question to be representative of the primary research questions and sub-questions to make a definitive generalisation (Saunders et al., 2019). Content validity is achieved when the literature and the research instrument are analysed and reviewed by experts in the field of research (Zohrabi, 2013; Taherdoost, 2016). Chapter 1 and 2 were frequently submitted for review. In addition, the online survey was reviewed by an expert to ensure that the survey questions were accurate and unbiased. The reviewer was a lecturer that holds a PhD in the field of Information Systems. The constructive criticism received further attributed to the content validity of the research.

Moreover, face validity is achieved when the data collected is accurate (Saunders et al., 2019). Whereby, the questions asked to the participants in the online survey were easy to comprehend. A pilot test was issued to four individuals to establish whether the question in the survey was easy to comprehend, unbiased and posed a logical flow. The pilot test was issued to colleagues and peers. The pilot test participants work in the field of Information Systems and are familiar with the concepts pertaining to smart communities and digital skills.

3.5.2 Reliability of the mixed methods approach

Reliability can be described as the ability of the research conducted to be replicated within other studies (Saunders et al., 2019). The researchers implemented an audit trail to ensure that the dependability of data collection was achieved. According to Saunders et al. (2019), dependability in interpretive research, the key focal points within the research may change as

the research progresses. The purpose of dependability is to monitor and record all changes made during the research process. This will allow for a reliable account of the research conducted and the possibilities for future research. The purpose of the audit trail is to stipulate how the data was collected and analysed, how the themes were established and how the findings of the study was determined (Zohrabi, 2013). Figure 7 depicts the process the researcher followed to ascertain reliable findings in this study. According to Cameron (2018), the audit trail presented below gives the researcher the ability to keep track and examine each phase within the data collection process. Thereby ensuring that reliability of the research was attained during the course of this study.

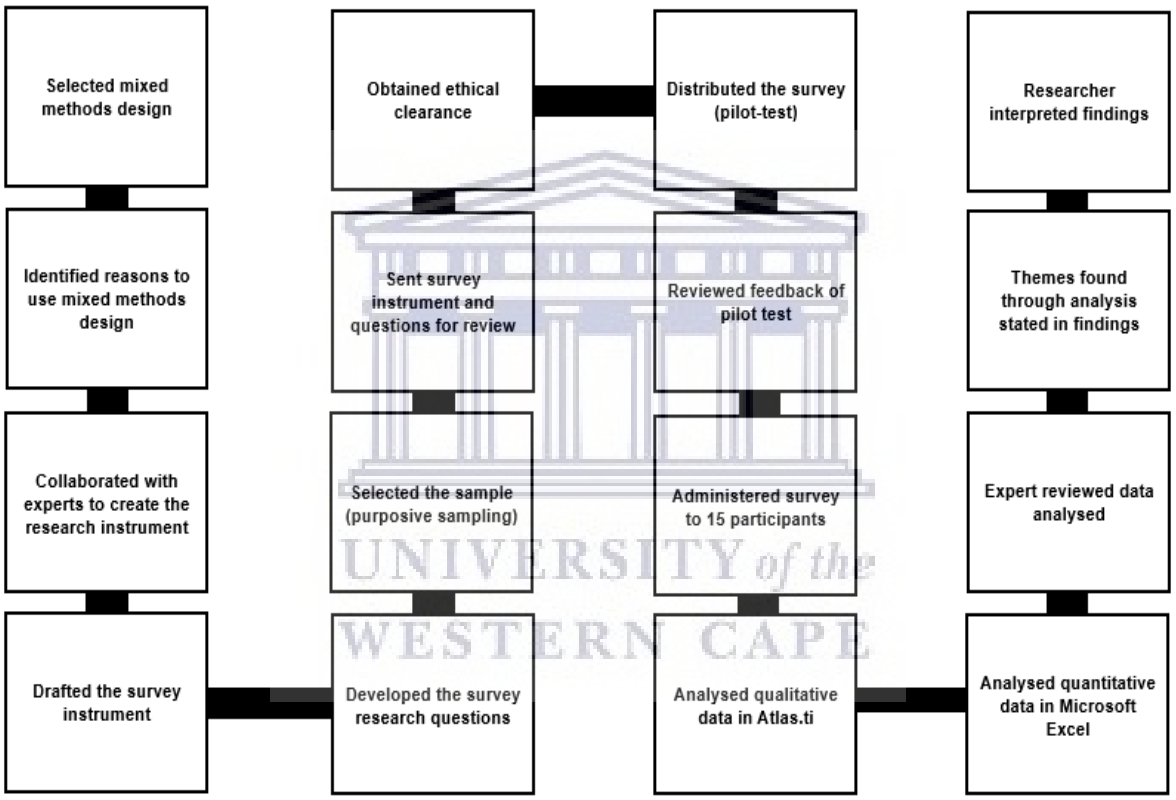


Figure 7: Audit trail of the data collection process

3.6 Ethical considerations

Ethics within the context of research refers to "the standards of behaviour that guide your conduct in relation to the rights of those who become the subject of your work or are affected by it" (Saunders et al., 2019:252). Ethical standards and behaviour were achieved and maintained by following to the Universities of the Western Capes research rules and regulations. Key ethical considerations made within the study were: no malevolent survey questions, informed consent by the participants, voluntary participation of the respondents and the right to anonymity and confidentiality of participants personal information in the study (DeVaus, 2002).

The research conducted during this study was approved by the Humanities and Social Science Research Committee. Appendix A presents the ethical clearance documentation as approved by the Ethical Clearance Committee.

Confidentially of the participants, identity was of utmost importance to the researchers. Participants were assured that their identity would remain anonymous and protected throughout the study. The researchers safely stored the participants information in a password-protected Google Drive folder to ensure that their identity would remain anonymous.

The participants had complete clarity of their role within the study. Critical details regarding background information about this study and rights of the participants were shared in the information sheet and consent form. Appendix C and D presents the information sheet and the consent form given to each of the participants within the study. All the participants had the opportunity to review the documentation and decide whether they would like to proceed to complete the online survey. The questions posed in the online survey were centred around the objective; to verify the digital skills necessary for students to function productively in a HE community, transitioning from a traditional campus environment to a smart campus community. Each participant had the right to discontinue their participation in the study due to adverse feelings towards a specific question presented in the online survey. Thus, participants could withdraw from the study at any point, without any consequences.

3.7 Chapter summary

Chapter 1 gave a detailed analysis of the background of the study. Further information related to the research problem, research questions, research objectives, the scope of the study, the significance of this study and the layout of the dissertation was presented in Chapter 1.

The purpose Chapter 3 was to outline and describe the research process of the study. Interpretivism was chosen as the philosophical discourse to best reflect the data collected and analysed in the study. A mixed methods approach was incorporated to generate a wealth of data from the online surveys distributed to the participants. The chapter detailed that the manner in which the data was analysed was by means of Atlas.ti. Other important areas of focus discussed in the chapter involved the use of UWC as a case study, using students as a sample, and establishing the measures used to ensure validity and reliability within the study.

The following chapter will highlight the demographics of participants, findings and discussions related to the data collected from the participants.

Chapter 4: Research findings and discussion

4.1 Introduction

The previous chapter identified the methodological background and research process that this study followed. In this chapter the researchers report on the demographic background of the participants in the study in table format. Thereafter, the researchers present the higher education community challenges, the challenge categories and the data analysis codes assigned to each challenge that were used within the qualitative data collection process. In this Chapter, researchers report on the data collected from the online survey. Once the summary of the findings has been discussed the researchers discuss the significance of the findings.

4.2 Demographics of participants

Starting with the gender of the participants, 7 out of 15 identified as male while 8 out of identified as female. The majority of the research participants identified as people of colour. Coloured individuals represented 8 out of 15 of the sample, African people represented 5 out of 15 of the sample, Indian and Mixed Race represented 1 out of 15 of the sample, respectively. The majority of the participants were between the ages of 25 – 43, accounting for 8 out of 15 of the sample. The remainder of the ages of the participants were distributed as follows, 18 – 24 (4 out of 14 of the sample), 35 - 44 (2 out of 15 of the sample) and 45 – 54 (1 out of 15 of the sample). 12 out of 15 of the respondents noted that they resided off-campus before the COVID-19 pandemic. While 1 out of 15 of the participants resided at a campus residence outside the borders of the campus premises and 2 out of 15 of the respondents resided within the campus borders. The majority of the respondents noted that they are currently in pursuit of the diploma/undergraduate degree (10 out of 15). The minority of the participants noted that they are either in pursuit of an Honours (3 out of 15), Master's (1 out of 15), or Doctorate degree (1 out of 15). Finally, 8 out of 15 of the students noted that they are currently students at the case study institution students, while 7 out of 15 noted that they are not.

Table 7: Demographics of participants

Demographics of participants			
Category	**Items**	**Amount**	**Percentage**
Gender	Male	7	47%
	Female	8	53%
	Total	**15**	**100%**
Ethnicity	African	5	33%
	Coloured	8	53%
	Mixed race	1	7%
	Indian	1	7%
	Total	**15**	**100%**
Age	18-24	4	27%
	25-34	8	53%
	35-44	2	13%
	45-54	1	7%
	Total	**15**	**100%**
Residential circumstance (pre-COVID-19)	Residing on-campus	1	7%
	At campus residence 'off - campus'	2	13%
	Off-campus	12	80%
	Total	**15**	**100%**
Currently studying	Diploma/Undergraduate degree	10	66%
	Honour's degree	3	20%
	Master's degree	1	7%
	Doctorate degree	1	7%
	Total	**15**	**100%**
Current case study institution student	Yes	8	53%
	No	7	47%
	Total	**15**	**100%**

4.3 Findings of qualitative and quantitative data

4.3.1 Findings 1: Presentation of qualitative data

In the following section, the challenges faced by HE communities who transition into a smart campus community are presented, alongside the category in which each challenge resides. Additionally, the 38 codes used within the qualitative analysis are presented in the tables below.

Table 8: Summary of findings related to the foundational phase

No	Challenge	Category	Codes determined by qualitative analysis
1	Access to digital devices	Foundation	Digital devices challenge Digital access solutions Possession of digital devices
2	Access to network/internet connection	Foundation	Network/internet connection challenge Current connection to internet connectivity
3	Basic digital skills	Foundation	Digital skills Current basic digital literacy skills Current user skills UWC basic skills (Iteration 2) UWC user skills (Iteration 2)
4	On and Off- site mobility	Foundation	On and off- site mobility solution On and off- site mobility digital skills

Table 9: Summary of findings related to the Core services phase

No	Challenge	Category	Codes determined by qualitative analysis
5	Physical safety of students	Core Services	Physical safety challenge Physical safety solutions Physical safety digital skills
6	Data privacy	Core Services	Data privacy challenge Data privacy solution Data privacy digital skills
7	Student administration	Core Services	Student administration challenge Student administration solution Student administration digital skills

No	Challenge	Category	Codes determined by qualitative analysis
8	iKamva (LMS)	Core Services	iKamva LMS challenge iKamva LMS digital skills iKamva solution

Table 10: Summary of findings related to the Integration phase

No	Challenge	Category	Codes determined by qualitative analysis
9	Innovative study spaces	Integration	Innovative study areas challenge Innovative study areas technological solutions Innovative study areas digital skills
10	Health (Iteration 2)	Integration	Health challenge Health solutions Health digital skills
11	Food security	Integration	Food challenge Food solutions Food digital skills

Table 11: Summary of findings related to the Transformation phase

No	Challenge	Category	Codes determined by qualitative analysis
12	Facial recognition	Transformation	Sustainability challenge Sustainability technology Sustainability solution

Table 12: Summary of the findings related to Stakeholder responsibility

Challenge	Category	Codes determined by qualitative analysis
Stakeholder Responsibility	Stakeholders	Stakeholder challenge Stakeholder solution

4.3.2 Findings 2: Responses related to the quantitative data

The following section describes the quantitative data collected from the online survey.

Responses related to the challenges (iteration 1)

The closed-ended questions related to each challenge within the individual smart campus phases are presented below. A key to the different phases as they relate to specific questions, is shown in Table 13. The data was compiled in Microsoft Excel. The answers of the respondents have been presented in a percentage format. Each percentage indicates whether a respondent answered "Yes", "No" or "I do not know" to a question.

Table 13: Key to comprehend Table 14

Key	
Orange	Foundational challenges
Green	Core Services challenges
Blue	Integration challenges
Red	Sustainability challenges

Table 14: Statistical findings of the online survey

Challenge question	Yes (%)	No (%)	I do not know (%)
F7. Q22 Do you agree [on and off-site mobility] that this is in fact a challenge students experience?	93	7	N/A
F7. Q23 Do you think optimization of on - campus digital services might benefit you and your peers? (For example: implementing a parking assistance app)	100	0	N/A
F7. Q24 If you stay far from campus, do you think you and your peers might benefit from an optimized system to either locate parking/find the nearest routes to classes on campus?	100	0	N/A
C2 Q26 Have you ever felt unsafe walking or driving alone on campus?	60	40	N/A

Challenge question	Yes (%)	No (%)	I do not know (%)
C2 Q27 Do you think that physical safety on campus is a challenge students experience?	53	33	13
C2 Q29 Do you think we could use technological advancements to solve this challenge? (For example: a campus safety app)	67	0	33
C3 Q31 Are you ever concerned using your personal data online? For example: Using your ID number to access your student email account.	80	20	0
C3 Q32 Do you think the use of personal data on online platforms is a challenge students experience?	87	0	13
C3 Q34 Do you think we could use technological advancements to solve this challenge? For example: Making use of a Virtual Private Network (VPN) to safeguard personal information.	60	0	40
C4 Q37 Do you think that this [e-learning] is in fact a challenge students experience?	100	0	0
C4 Q39 Do you think we could use technological advancements to solve this [e – learning] challenge?	100	0	0
C5. Q41 Have you ever struggled to attend face-to-face classes, or online classes?	93	0	7
C5 Q42 Do you agree that this [iKamva] is in fact a challenge students' experience on campus or online?	80	13	7
C5 Q44 Do you think this challenge can be solved using technological advancements?	67	13	7
C6 Q46 Have you ever struggled to use iKamva?	80	13	7
C5 Q47 Do you agree that this [student administration] is in fact a challenge students experience?	60	27	13
C5 Q49 Do you think this [student administration] challenge can be solved by means of technological solutions?	93	7	0
I1 Q51 Do you think UWC lacks innovative/creative study areas?	80	7	13
I1 Q52 Do you think that this [lack of innovative study areas] is in fact a challenge students' experience on-campus?	80	0	20
I1 Q54 Do you think we could use technological advancements to solve this [lack of innovative study areas] challenge?	87	0	13
I3 Q61 Have you ever experienced any challenges related to food on campus? For example: Restaurants closing due to the pandemic/ lack of nutritional food on campus/food scarcity	67	33	0
I3 Q62 Do you think that this [food scarcity] is in fact a challenge students' experience on campus?	80	0	20
I3 Q64 Do you think this challenge can be solved using technological advancements? For example: Community garden powered by solar power and smart gardening equipment/ an app to show restaurant location, price lists, and availability.	87	0	13

Challenge question	Yes (%)	No (%)	I do not know (%)
S1 Q66 Would you accept facial recognition systems to monitor movement and class attendance on campus?	53	47	0

Responses related to challenges (iteration 2)

Iteration 2 included additional questions related to the digital skills training students received at the case study institution. This was particularly important, since COVID – 19 was having a significant impact on the daily operation of the university. The researcher incorporated additional questions pertaining to the digital skills training and health and wellness challenges that participants faced within the HE community. Each percentage indicates whether a respondent answered "Yes", "No" or "I do not know" to a question.

Table 15: Key to comprehend Table 16

Key	
Orange	Foundational challenges
Blue	Integration challenges

Table 16: Statistical findings related to additional survey questions (iteration 2)

Challenge question	Yes (%)	No (%)	I do not know (%)
F5 Q18 Have you received any basic digital skills training at UWC? For example: Transacting online, creating content (spreadsheets, text, slides), using mobile applications.	20	67	13
F6 Q20 Have you received any user skills training at UWC? For example: Microsoft Word/Excel, web surfing, online communication (Zoom), online privacy and security training?	33	47	20
I.2 Q56 In terms of your health and wellness, do you have any concerns returning to campus post -pandemic?	86	7	7
I2 Q57 Do you think that this is in fact a challenge some students experience?	93	0	7

Challenge 1: Access to digital devices

In terms the data collected from the participants. All the participants stated that they do have access to digital devices. However, the specific digital devices they have access to differ from one student to another. According to the responses from the participants, 13 out of 15 of participants own smartphones, 15 have access to a laptop. 9 out of 15 of the students have access to a tablet, 4 out of 15 of students

have access to a desktop computer. Finally, 1 out of 15 of the respondents owns a digital notebook. (See Figure 8)

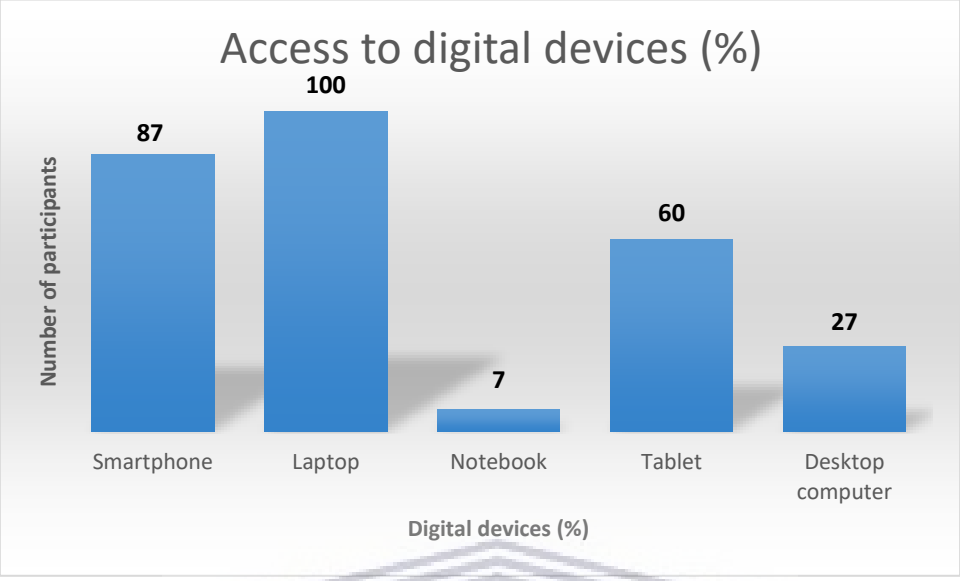


Figure 8: Proportion of respondents with access to digital devices

Challenge 2: Access to a network/internet connection

Students were asked to say whether they have access to a network/internet connection at their residential address. 13 out of 15 of the respondents noted that they do have access to internet services, while 2 out of 15 % of the students noted that they do not have access to internet connectivity at their residential address. The findings suggest that the majority of students do have access to internet connectivity at home. (See Figure 9)

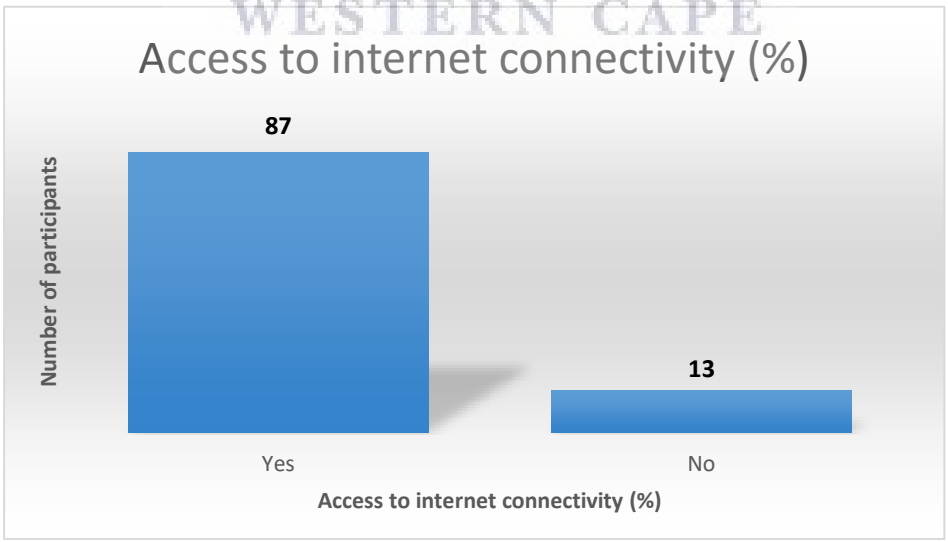


Figure 9: Proportion of respondents with access to internet connectivity

Challenge 3: Basic digital skills

Students were asked to rank their aptitude based on their own perception of their basic digital skills and user skills. Figure 10 below indicates that 9 out of the 15 respondents noted that they are very skilled pertaining to their problem-solving skills. Problem solving skills include making use of peer reviewed and reliable sources and to refrain from using mischievous websites and online scams (Claassen, 2017). The remaining participants noted that they are somewhat skilled (1 out of 15), highly skilled (4 out of 15), and one noted that he/she has received specialised training (1 out of 15) for basic digital skills.

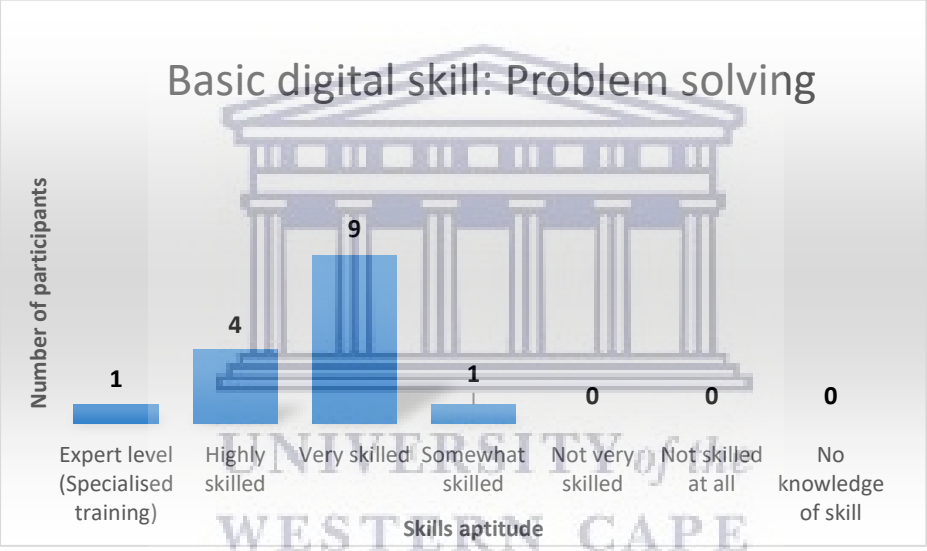


Figure 10: Proportion of respondents with basic digital skills (Problem solving)

Figure 11 indicates the basic digital skills related to handling information. Handling information includes navigating the internet by means of the search engine, understanding which platforms and websites to use of reputable sources for information, actively participating in reading, reviewing, skimming data on a digital device (Claassen, 2017). 9 out of 15 students noted that they are highly skilled at handling information using a digital device. The remaining respondents said that they are either very skilled (5 out of 15) or have received specialised training (1 out of 15) regarding handling information online using a digital device. The findings indicate that the students are well equipped to handle information.

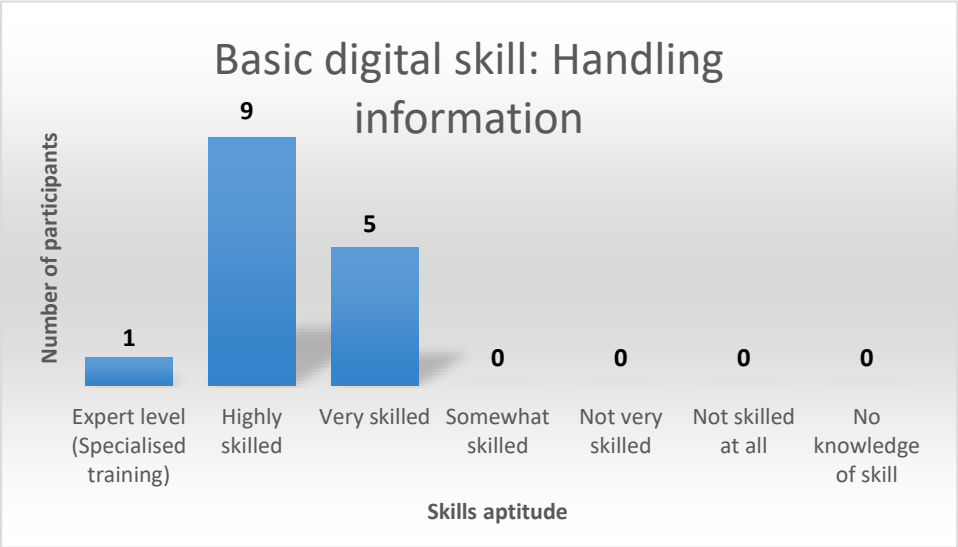


Figure 11: Proportion of respondents with basic digital skills (Handling information)

Figure 12 illustrates the basic digital skills related to transacting online. Transacting online includes making use of websites that are secure, securing personal data, protecting others by respecting their privacy (Claassen, 2017). 7 out of 15 students noted that they are highly skilled at conducting online transactions using a digital device. The remaining respondents said that they are either very skilled (6 out of 15), somewhat skilled (1 out of 15), or received specialised training (1 out of 15) regarding transacting online using a digital device.

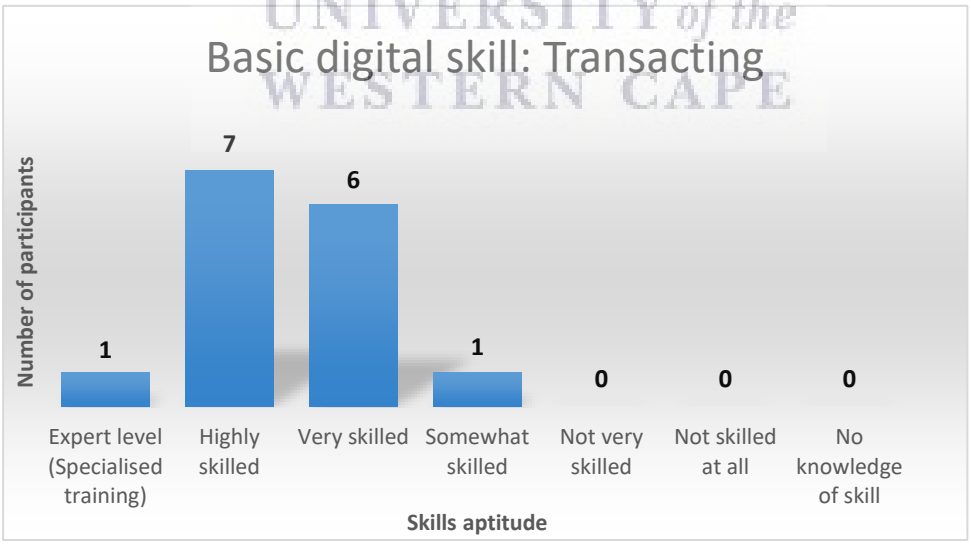


Figure 12: Proportion of respondents with basic digital skills (Transacting)

Figure 13 illustrates the basic digital skills related to online communication. Online communication includes comprehension of managing a digital identity on online platforms, understanding how to protect yourself from becoming a victim of cybercrimes, properly

managing security and privacy settings on digital devices, ensuring your data as a consumer is well protected from cyber scams (Claassen, 2017). 5 out of 15 students noted that they are somewhat skilled and very skilled (5 out of 15) at online communication using a digital device. The remaining respondents stipulated that they are highly skilled (4 out of 15). While 1 out of 15 respondents noted that they have received specialised training regarding online communications using a digital device.

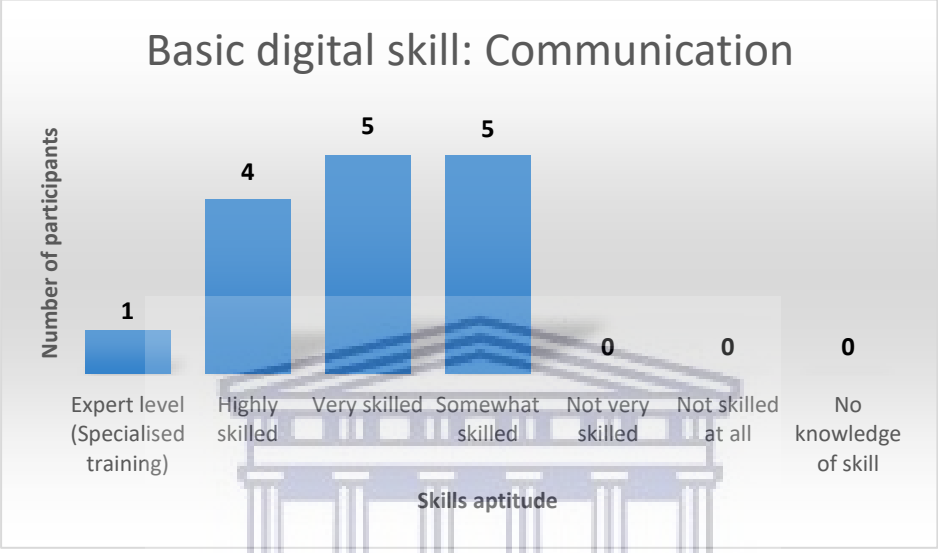


Figure 13: Proportion of respondents with basic digital skills (Communication)

Figure 14 illustrates the basic digital skills related to creating content online. Examples of content include text, documents, slideshows, photos, videos, recordings, spreadsheets. The ability to create content involves making use of spell check features, amplifying, reconstructing, correcting content, understanding how copyright works, and knowing how to generate storytelling content (Claassen, 2017). 7 out of 15 students noted that they are highly skilled at creating content using a digital device. The remaining respondents said that they are either very skilled (5 out of 15), somewhat skilled (2 out of 15), and one of the students noted that they are not very skilled regarding creating content online using a digital device.

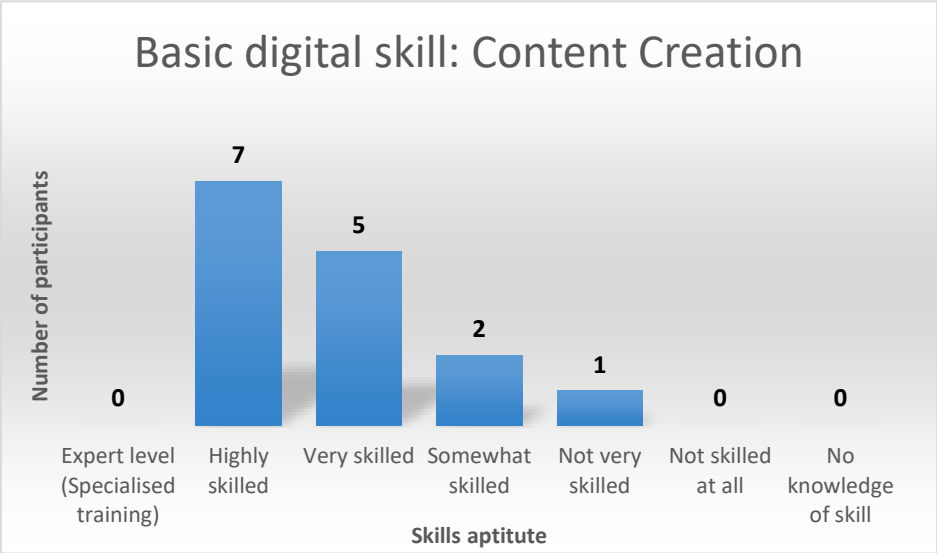


Figure 14: Proportion of respondents with basic digital skills (Content creation)

Figure 15 illustrates the basic digital skills that the participants use within their personal life. Using basic digital skills within the personal life of community members includes using mobile applications, playing audio and video files, making use of network connectivity, refraining from cyberbullying, using digital devices to expand your knowledge (Claassen, 2017). 11 out of 15 students noted that they are highly skilled using basic digital skills in the context of their personal lives. The remaining respondents said that they are very skilled (2 out of 15), while 1 out of 15 respondents noted that they have received specialised training and somewhat skilled (1 out of 15).

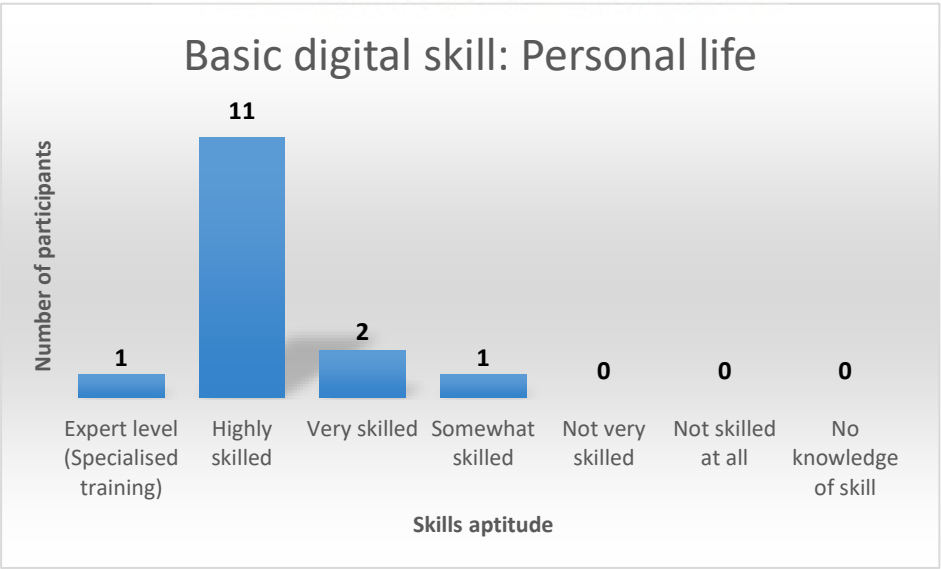


Figure 15: Proportion of respondents with basic digital skills (Personal life)

Figure 16 depicts the basic user skills related to using digital skills pertaining to word processing. Word processing entails using certain platforms and applications. These applications include Microsoft Word, Notepad, Google Docs (Claassen, 2017). 7 out of 15 students noted that they are very skilled at navigating and using word processing platforms and applications. The remaining respondents said that they are highly skilled (6 out of 15). While 1 out of 15 respondents noted that they have received specialised training and 1 out of 15 is somewhat skilled.

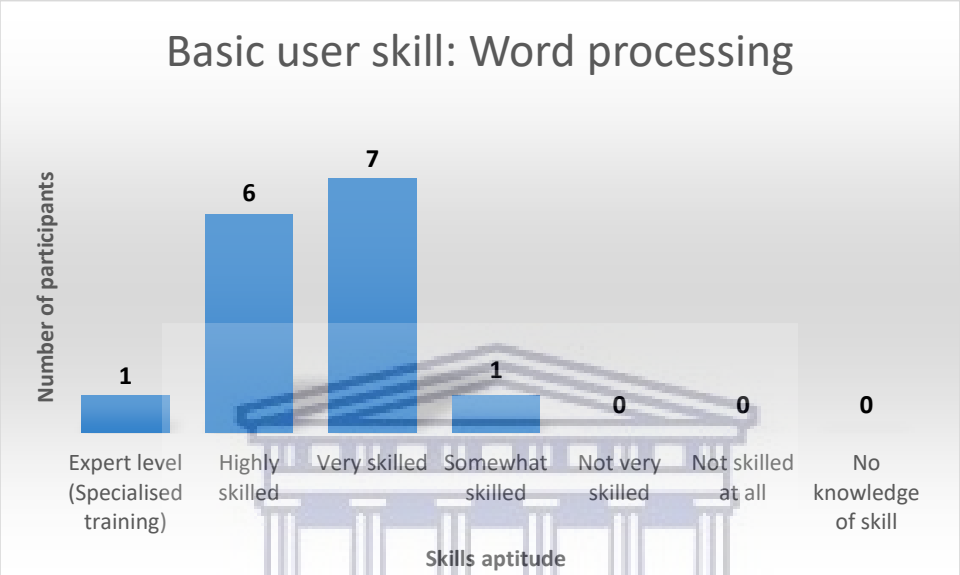


Figure 16: Proportion of respondents with basic user skills (Word processing)

Figure 17 illustrates the basic user skills related to using digital skills pertaining to spreadsheets. Spreadsheets entail using certain platforms and applications. These applications include Excel and Google sheets (Claassen, 2017). 5 out of 15 students noted that they are very skilled at navigating and using spreadsheet platforms and applications. The remaining respondents said that they are highly skilled (2 out of 15), while 1 out of 15 respondents noted that they have received specialised training. Finally, somewhat skilled (5 out of 15) and not very skilled (2 out of 15).

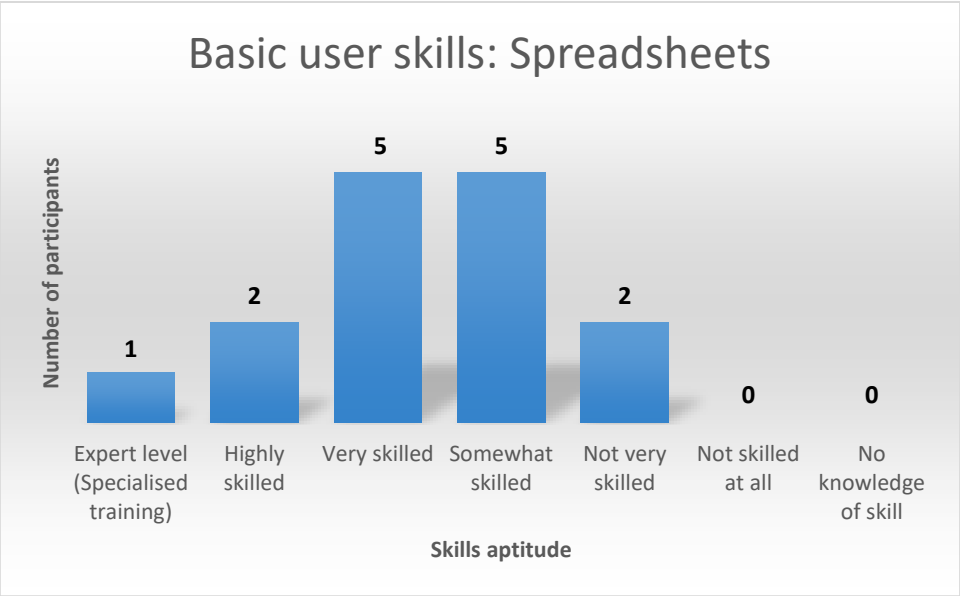


Figure 17: Proportion of respondents with basic user skills (Spreadsheets)

Figure 18 depicts the basic user skills related to using digital skills pertaining to web surfing. Web surfing entails searching for information using an internet browser. 10 out of 15 students noted that they are highly skilled at navigating and using the internet to search for data/information online. The remaining respondents said that they are very skilled (3 out of 15), received specialised training (1 out of 15) and somewhat skilled (1 out of 15).

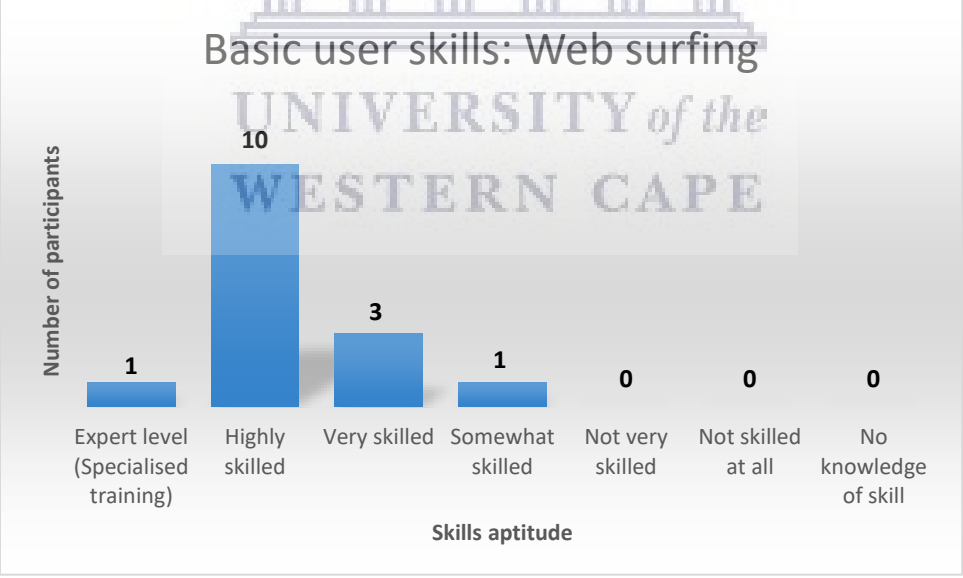


Figure 18: Proportion of respondents with basic user skills (Web surfing)

Figure 19 illustrates the basic user skills related to using digital skills related to collaboration and communication skills. Communication and collaboration skills entail using platforms and applications such as email, Zoom, Skype, iKamva, Sunlearn, Microsoft teams, Monday.com. 9 out of 15 students

noted that they are very skilled at navigating and using the internet to search for data/information online. The remaining respondents stipulated that they are highly skilled (6 out of 15).

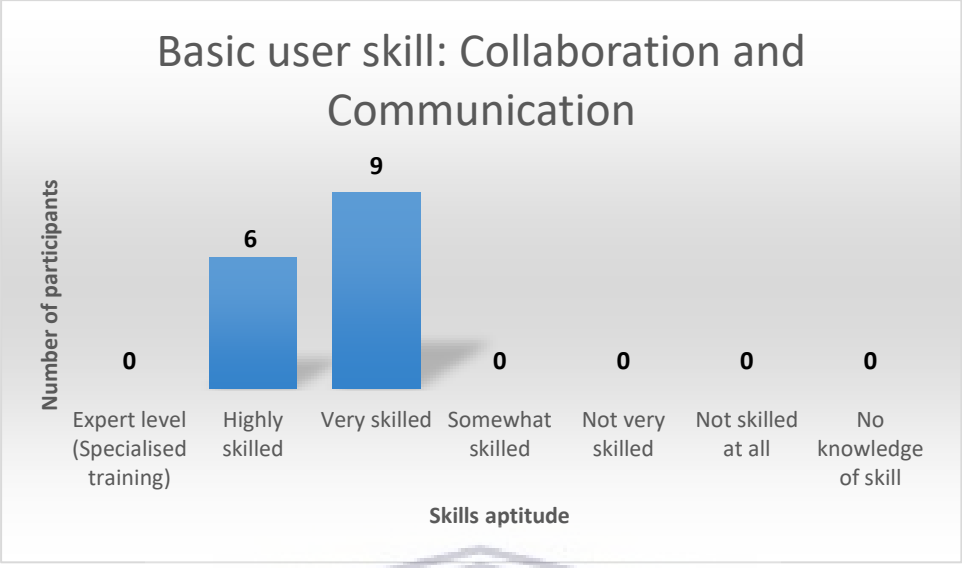


Figure 19: Proportion of respondents with basic user skills (Collaboration and communication)

Figure 20 below illustrates the basic user skills related to using digital skills pertaining to online privacy. Online privacy entail using Virtual Private Networks (VPN), safeguarding personal information online and managing online identity (Claassen, 2017). 4 out of 15 students noted that they are very skilled at ensuring that their online privacy is maintained. The remaining respondents stipulated that they are highly skilled (3 out of 15), not very skilled (3 out of 15) and somewhat skilled (2 out of 15), respectively and not skilled at all (1 out of 15).

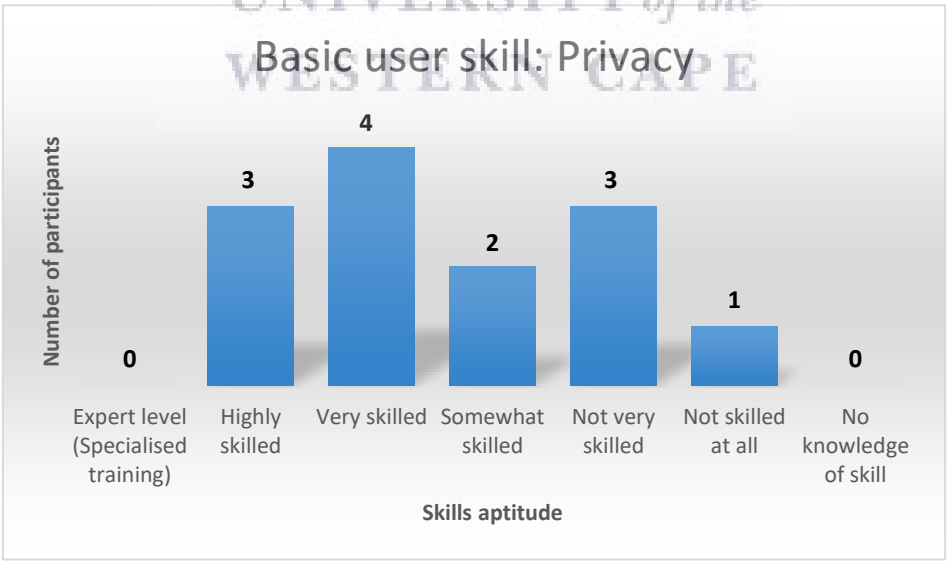


Figure 20: Proportion of respondents with basic user skills (Privacy)

Figure 21 illustrates the basic user skills related to using digital skills pertaining to online security. Online security entails knowing how to protect yourself physically using mobile applications. 8 out of

15 students noted that they are somewhat skilled at protecting themselves physically using online applications. The remaining respondents said that they are highly skilled (3 out of 15), not very skilled (2 out of 15) and very skilled (2 out of 15).

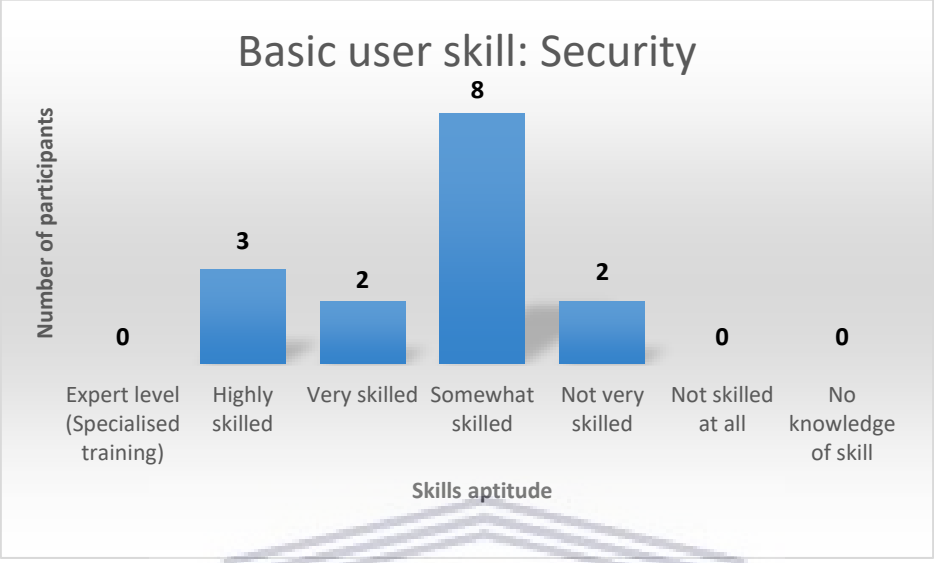


Figure 21: Proportion of respondents with basic user skills (Security)

Figure 22 illustrates the basic user skills related to using digital skills pertaining to the use of social media. Social media entail the use of online applications and platforms which include Facebook, Whatsapp, Instagram and TikTok. 7 out of 15 participants noted that they are highly skilled at navigating and making use of social media applications. The remaining respondents said that they are very skilled (6 out of 15). The remainder of the participants noted that they are somewhat skilled (2 out of 15).

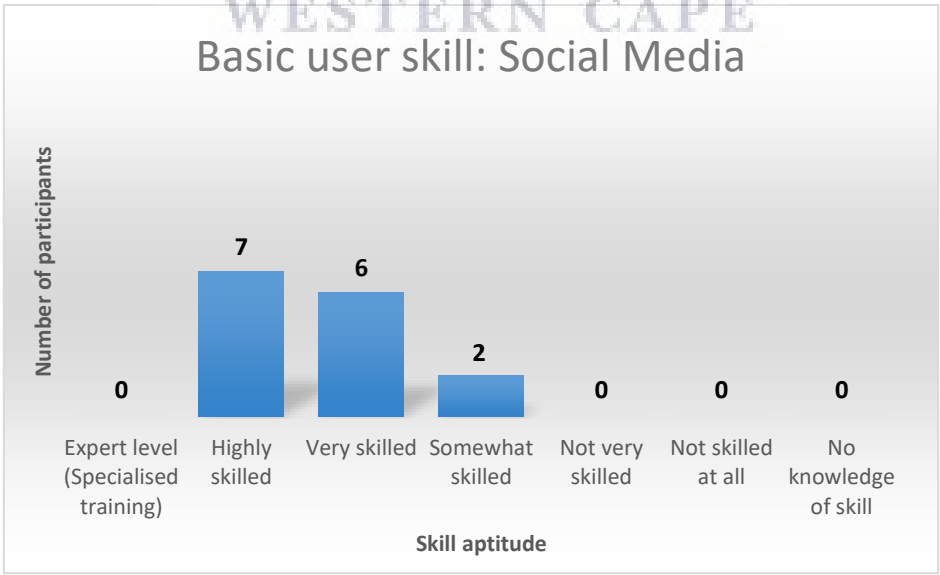


Figure 22: Proportion of respondents with basic user skills (Social media)

Figure 23 illustrates the basic user skills related to using digital skills pertaining to cloud services. Cloud services entails comprehending how to use cloud services. 6 out of 15 students noted that they are very skilled in understanding how to use cloud services and applications. The remaining respondents stipulated that they are highly skilled (5 out of 15), are somewhat skilled (2 out of 15) and have received specialised training (1 out of 15).

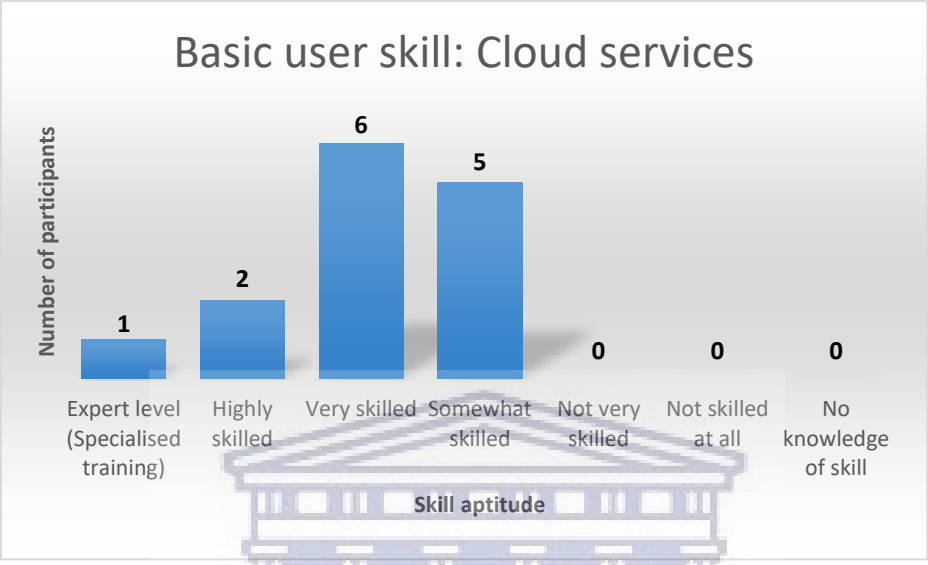


Figure 23: Proportion of respondents with basic user skills (Cloud services)

Figure 24 illustrates the basic user skills related to using digital skills pertaining to ethical online behaviour. Ethical online behaviour refers to refraining from engaging in cyberbullying, respecting the opinions and views of other persons online, and engaging professionally with community members on digital platforms and applications (Claassen, 2017). 6 out of 15 students noted that they are highly skilled as far as engaging in ethical online behaviour is concerned. The remaining respondents said that they are very skilled (5 out of 15), are somewhat skilled (1 out of 15), not very skilled (1 out of 15), and not skilled at all (1 out of 15).

Figure 24: Proportion of respondents with basic user skills (Ethical online behaviour)

4.4 Discussion of quantitative and qualitative findings

4.4.1 Discussion related to the Foundational phase

Challenge 1: Access to digital devices

Access to digital devices in a campus transitioning from a traditional campus environment to a smart campus environment is a foundational challenge. The findings indicate that 13 out of 15 of the respondents have access to smartphones, all have access to laptops, one has access to a digital notebook, 9 out of 15 have access to a tablet and 4 out of 15 of respondents have access to a desktop computer at their residential address. The data confirms that a majority of the 15 students have access to digital devices. This indicates that of the 15 students, this challenge has in part been solved. However, the researcher postulates that it is necessary to ensure that all students have at least access to a smartphone. As described in the data, 13 of students have access to a smartphone. In order to function optimally in a smart campus community, it would be advisable for all students to have access to at least a smartphone. Students having access to a laptop yielded positive results as 100% stated they possess the digital device. From the 15 respondents, the researcher affirms that the access to digital devices among the 15 students is saturated. However, some of the respondents' noted that access to digital devices on campus can be challenging. For example, the responded stated,

"Trouble accessing PC resources on a library and EMS faculty level" (Case 14).

Another student noted that while moving towards a smart campus community is important, certain foundational challenges need to be solved first. For instance, the student stated,

"I would not like to see the university spend tons of money on all of this tech when it is still trying to solve the issue of data and devices for students. I feel that if the students don't have access to devices and data – any of the tech recommendations will be a gross misallocation of capital and will visually perpetuate the digital divide we are currently experiencing" (Case 2).

This student (Case 2) mentioned that if the foundational challenge is not resolved, the inclusivity regarding access to digital devices and internet connection of students will be threatened. It should be important to note that during the pandemic the case study institution offered their students the opportunity to purchase laptops that included a Microsoft Office Suite. The Microsoft Office Suite package was given free of charge. The cost of the laptop was R6379,05. Through this initiative the case study institution has revealed their ability to help bridge this gap in the digital divide.

The data indicates that while the majority of the students have access to digital devices at their residential address, locating digital devices remains a challenge for the respondents. In addition, as indicated by the findings, careful consideration must be made to ensure that all students have access to digital devices to function optimally in a smart campus community. This is especially important during the COVID-19 pandemic, when the majority of the lectures take place online and daily, tasks are performed remotely.

Challenge 2: Access to and internet connection

The study theorises that in order for a traditional campus to mature into a smart campus community certain challenges need to be addressed. The second challenge on this journey addresses the participants access to an internet connection. In iteration 1, 13 out of 15 of the participants note that they have access to an internet/network connection at their residential address. It is important to realise that during the second iteration, 100% of the students note that they have access to an internet/network connection at their residential address.

The iterations were split between pre-COVID-19 and during COVID-19 pandemic. The data indicated that after the participants were instructed to return to their primary residence, they proceeded to use the internet connection available in their local communities. Even though all respondents had access to internet connection at home, one responded noted that the connection may be poor at times.

The respondent stated,

"Since the pandemic I've been back at home, I think an improvement in internet speed when attending online classes would have helped me. I usually downloaded the classes afterwards because our internet connection is weak" (Case 1).

Although students have access to internet connection at their residential address, the strength of the connection needs to be taken into consideration. The researcher affirms that in order for remote learning to take place in a smart campus environment, a strong internet connection is necessary. Additionally, another theme arises that suggests that placing importance on *access to an internet connection* may not be the only challenge students face. An additional theme that arises is the strength of the internet connection to allow for effective online learning. The new theme presents the argument related to identifying who the stakeholder groups and individuals are that can supply a stronger internet connection to students.

It is important to note that the case study institution, has distributed data packages to students in need, to facilitate the need for remote learning. The packages available to students working remotely are 10GB of daytime data per month and 20GB night-time data per month for 3 months, starting 1 May 2021. The data allowance is only allocated to 7500 students. This could in fact leave some students vulnerable to not being able to receive access to data services. However, the case study institution has made strides to solve the challenges related to access to internet services. The data affirms that access to internet connection and data services is crucial to ensure that students can work remotely in a smart campus environment. Additionally, the case study institution provides access to internet connectivity on campus. The internet connectivity is available for all staff members, students, and guests on the campus premises. Furthermore, the university has provided their staff and students with virtual private network (VPN) services. Lastly, the case study institution has implemented a zero-rate website for community members and outsiders to browse the official university website. Therefore, the case study institution has implemented innovative solutions to combat the challenge related to access to internet services. The allowances and additions made by the case study institution are indicators that the university is in fact actively bridging the challenges gap related to internet access.

Challenge 3: Digital skills

The researcher affirms that a traditional campus transitioning to a smart campus community needs community members to acquire basic digital skills to ensure that the community members (students) can function optimally in the technology intensive environment. The data presented in the findings indicates that the 15 students are well equipped concerning basic digital literacy skills. The basic digital literacy skills that students were most equipped to perform are *problem solving, handling information, transacting,* and *personal life skills*.

Basic digital skills

The majority of the students selected *expert level, highly skilled* and *very skilled* when scoring themselves on the fields mentioned above. However, there was considerable room for improvement when it came to the following basic digital skills, namely, *communication* and *content creation.* Five students indicated that they are somewhat skilled in digital communication skills and 2 out of the 15 students noted that they are somewhat skilled in content creation, 1 self reportedly being not very skilled. The data indicates that much consideration must be given to *communication* and *content creation* skills of students as a

campus transitions to more digital and online ways of working. When asked whether students have received basic digital literacy skills training at the case study institution, 3 out of 15 of the respondents said "Yes", 10 out of 15 "No", while the remaining students stated that they "received some training". 20% of the respondents noted that the digital skills training received was introductory in nature. For instance, a number of respondents stated,

"We had very fundamental digital skills training. For example, how to switch on a computer, how to find different applications. How to highlight text, store and copy files. We did not spend much time improving our skills as the years followed. We had to navigate the application on our own for the most part. Many of the lecturers and admin assisted us to learn digital skills" (Case 3).

and

"Basic digital literacy skills like finding resources online (library services)" (Case 5).

and

"I have received some training geared towards finding proper information online, how to use a search engine, content creation. Also, UWC sometime send emails for final years, honours and post graduate students to assist them with their studies. Common emails I've seen was related to training for Atlast.ti, SPSS, Mendeley etc" (Case 10).

Several of the respondents who selected the option to declare that they had not received training for basic digital skills, detailed that they however, received training that was geared toward user skills. For instance, the following respondents stated,

"Most of the skills were geared towards user skills. After first year the lecturers helped us navigate iKamva and any other application we needed for a module. I usually just use Youtube to help me out. Youtube has helped me with most of the questions I have when it comes to the use of an application" (Case 12).

and

"Most of the training was related to user skills. We did receive some training regarding the proper use of a computer. But nothing related to mobile applications" (Case 15).

The findings further indicate that respondents received some training pertaining to basic digital skills and user skills from different individuals, departments, and online resources. For example, respondents declared,

"I have received some training more related to content creation in the first few years of my studies. As my studies progressed the lecturers helped us more with regarding to basic digital skills like understanding most of the functions, using the library site, finding valuable information online etc" (Case 14).

and

"Most of the skills were geared towards user skills. After first year the lecturers helped us navigate iKamva and any other application we needed for a module. I usually just use Youtube to help me out. Youtube has helped me with most of the questions I have when it comes to the use of an application" (Case 12).

and

"I think as a post-grad I've received a lot of assistance. The post-grad department really does a lot to assist students. Especially if you ask for help. I can't really remember taking any basic digital literacy classes while being undergrad, but I've received a lot of assistance from the Post-grad department. They have sessions where they teach you how to navigate an application, store data safely, and what the differences are in the application usage. They regularly post their updated via UWC email" (Case 13).

A common theme among the respondents is that, in their view, a lot of emphasis was placed on user skills training rather than basic digital literacy skills training. In order for a traditional campus community to transition to a smart campus community, students should be equipped with the necessary basic digital literacy skills. The data further indicates that there are key stakeholders that supply the basic digital skills to the students. The stakeholders include lecturers, post-graduate departmental services, and online resources. Another key factor presented in the data is that students use online resources as a means to acquire digital skills. This situation makes students and lecturers key stakeholders in the supply of digital skills along with the other stakeholders mentioned above.

User skills

The basic user skills that students are most equipped to perform are *word processing, web surfing, collaboration and communication, social media,* and *ethical online behaviour*. Majority of the students selected expert level, highly skilled and very skilled concerning the fields mentioned above. However, improvement is necessary for the following digital user skills, *spreadsheets, privacy, security* and *cloud services*. According to the findings, 5

respondents noted that they are somewhat skilled using *spreadsheets* via Excel and Google sheets. While 2 out of 15 noted that they are not very skilled. The data concerning online privacy and security indicated that students are not well equipped to protect themselves online. Respondents indicated that 2 of them were somewhat skilled, 3 were not very skilled and 1 participant was not skilled at all. The user skill related to security presented a similar challenge as 8 students noted that they are somewhat skilled and 2 of the students stated they are not very skilled. Challenges also exist for user skills such as cloud services. 5 students noted that they are somewhat skilled concerning cloud services. 5 out of 15 of the students noted that they received basic user skills training, 7 out of the 15 stated they did not receive any user skills training and 3 out of 15 of the respondents state they received some training geared towards user skills. The respondents stated that user skills training mainly included skills related to navigating Microsoft Office programmes and applications. For example, the participants stated,

"Mostly Microsoft Suite skills. Word processing, Excel spreadsheets and Power Point" (Case 5).

and

"The Boe lab offered classes related to word processing, excel training and Power Point" (Case 9).

and

"I received training in word, excel and some PowerPoint training" (Case 13).

Another participant placed emphasis on the fact that lecturers, online resources and self-study were key in developing his/her user skills abilities. The respondent stated,

"In my first year we received training for Word. Not so much Excel or Power Point. The rest we had to learn on our own. The lecturers helped us out when we were stuck. Especially when using specific function in Excel Vlookup, Pivot tables. These functions are useful for a lot of models. But we had to learn most of this by ourselves making use of online resources like Udemy and youtube. Youtube was such a valuable platform during my studies. Anything you want to learn or know is most likely on Youtube" (Case 15).

The data indicates that students have certain areas that need improvement in order to solve the challenges they have regarding user skills. The areas that need attention based on the respondents' answers are spreadsheets, privacy, security and cloud services. The data further

indicates that the user skills training sessions students have been exposed to have been geared towards Microsoft Office programme training. The students are equipped to use word processing. However, their aptitude concerning spreadsheets needs to be developed. Other areas that lack user skills training by the universities are those geared towards cloud services, online privacy and security skills.

Similar to access to basic digital skills, user skills involve multiple stakeholders. The data indicates that students make use of online resources, self-study and the assistance of lecturers to obtain new user skills. Thus, the role which lecturers play in supplying both user and basic digital skills is crucial in supplying digital skills to HE community members. Moreover, students have taken responsibility for developing their digital capacities into their own hands by making use of online services. Hence, both students and lecturers are critical components in the supply of digital skills to HE community members who are transitioning to a smart campus community.

Challenge 4: On and off-site mobility

The students were presented with the following challenge related to onsite mobility as part of the online survey.

"Flexibility in terms of mobility on campus is a key concern smart universities face. On campus mobility refers to the ability of university management to ensure that physical activity is more efficient to improve the productivity of community members. (Example: Parking). Mobility in terms of locating the nearest route to classes, finding parking and locating the nearest food services remains a challenge within traditional campus environments."

The data indicate that 14 of 15 of the participants agreed that this is in fact a challenge they experience on campus. All 15 respondents agree that the challenge can be solved by an optimized technological system that improves the efficiency of movement on campus. For example, a parking application. Students further described the digital skills they think are necessary to navigate the parking application. Some of the respondents stated,

"Problem solving skills. Knowing how to use the functions of the app. Sending info of parking to other students. Navigating the app" (Case 4).

and

"I think it is so difficult to find parking on campus. I think we need classes to understand the app created. Like how to use the best Wi-Fi so that the app constantly updates the info" (Case 9).

and

"To use an application, you need to you need to understand how to use proper network to get the best signal. You need critical thinking skills to use the technology depending on how user friendly the app is. Application related skills, for instance, knowing and understanding the appropriate tool to use on the app. Mobile fundamental skills. For instance, knowing how to download an application, place the app on a proper pace on the screen, setting up privacy measures for your mobile etc" (Case 15).

Cases 10, 11, 12, and 14 had similar answers emphasising the importance of basic digital skills needed to use a parking application. The answers were *"basic dig skills"*, *"Basic skills digital"*, *"digital literacy"* and *"basic understanding of mobile app"*.

The researcher affirms that in order for a traditional campus to transition into a smart campus community, the challenge of mobility has to be addressed using technological innovation in conjunction with digital skills. The research indicated that students understand that mobility is a challenge on campus. They further agree that this challenge can be solved by means of digital innovation. Moreover, the findings indicated that the digital skills participants deemed necessary to make use of digital innovation includes *basic digital literacy skills, problem solving skills, mobile fundamental skills* and *critical thinking skills*.

4.4.2 Discussion related to the Core services phase

Challenge 5: Physical safety

In terms of physical safety, the students were presented with the following challenge in the online survey,

"Physical safety is critical within the borders of a campus community in order for students and staff to learn and teach successfully. Students and staff need to feel safe in the environment in which the study and work."

10 out of 14 of the respondents noted that they have felt unsafe walking or driving alone on campus. 8 out of 15 of students agree that the threat to physical safety is in fact a challenge students' experience of campus. During iteration 1 (before the pandemic) students noted that

an increased number of security guards on campus would make them feel safer on campus. For example, the respondents stated,

"More security on campus" (Case 2).

and

"More on-site security" (Case 7).

and

"Patrol on campus more often" (Case 10).

and

"More security on the premises" (Case 13).

The data indicates that more technologically intensive solutions were shared during the second iteration (during the pandemic). The respondents stated the following regarding improving safety measures on campus,

"The use of smart cameras could possibly identify dangerous situations. This real time information could be sent to security offices/systems to which they can respond in time" (Case 1).

and

"An application that helps students alert the security of where there might be danger" (Case 3).

and

"I think a real-time virtual mapping of the campus to see where most students are at a certain time and place might give a student a safer route to walk. Also, establishing hotspots where most of the violence/harassment of students happen. Presenting that data to students. Or a service that could drive the students from one pint to the next at a small cost" (Case 15).

When presented with a technological solution to assist the students with their physical safety, 10 out of 15 noted that a safety application would assist them to feel safer on campus grounds. However, 5 out of 15 of the respondents did not know whether a safety application could help them feel safe while roaming within campus borders. The respondents stated that certain digital skills are necessary to use the safety application. The respondents noted the following regarding the need for digital skills,

"Critical thinking skills, to know which tool will best help them to solve their issue. Skills to understand each function in the application. And knowing how to change networks to get the best signal" (Case 3).

and

"If the app presents data on where the hotspots are you need data analysis skills. For example, if they give a map of the campus in the app you need to critically think where you are and how to avoid these areas" (Case 11).

and

"Basic understanding of mobile applications" (Case 13).

Some students placed an emphasis on ethical online behaviour when using the proposed safety application. The respondents stated the following,

"Ethics plays a big role in this scenario, if an application is created, students should refrain from posting fake information. Other skills would be application skills, basic literacy skills and typing speed" (Case 1).

and

"Mobile fundamentals to know how to use the function of a mobile. Applications skills related to the use of the app. Responsible use of the application. For instance, making sure you don't spread fake news on the application, or you protect your/other identity" (Case 15).

The data indicates that the majority of students understand that physical safety is a challenge on campus that can be solved by means of technological advancement. The digital skills mentioned to make use of the proposed safety application include *critical thinking, application skills, data analysis, basic digital literacy skills, online privacy skills* and *ethical online behaviour*. The participants could identify the key digital skills necessary to successfully make use of a safety application.

Challenge 6: Data privacy

The respondents were presented with the following challenge related to online data privacy in the online survey.

"Privacy in terms of personal protection of your data is of critical importance in a campus community. Many threats exist to compromise and steal certain personal information."

The data indicated that 12 out of 15 of the respondents agreed that sharing personal information online is a challenge they experience. In response to their fear of sharing personal data online, the respondents noted that they prefer to use the manual systems on campus to share their information. For example, during the first iteration respondents stated the following,

"I hardly ever send my information online. I would rather hand in information at the admin offices. They know how to upload the documentation better than me" (Case 4).

and

"I always take physical data to the points where needed. I hardly make use of online systems. Admin in various departments helps me upload my data" (Case 5).

During the pandemic the majority of the administrative services and procedures were placed online. Iteration 2 reflected the change in attitude towards sharing personal data online. The respondents shared inputs on how they and the university can ensure that their data is protected online. For instance, the respondents stated,

"2 step authentication process for our email and student accounts" (Case 6).

and

"After covid I think we are more vulnerable than ever, I think we need training in VPN services how to conduct yourself online, how cookies work. Know how companies/hackers might be tracking you. I think we need to know more about cyber security in order to protect out data" (Case 9).

and

"Knowing that the university is following the governmental POPI Act to safeguard our information. Also give us the opportunity to protect our data. UWC implemented VPN functionality which makes it safer for students to share information online without being tracked or a victim of cybercrimes" (Case 15).

Cases 4, 9, 10, and 11 affirm that "*basic digital skills*" and *"Understanding what function to make use of in an app*" and *"Basic understanding of how a VPN works and how this could help safeguard information."*, are necessary to make use of a digital solution. The data indicates that the majority of students do not feel at ease sending their personal information online. They understand that certain digital skills are necessary to ensure that their data remain safe from possible cyber threats. Since the pandemic, the case study institution has implemented VPN

services for students working remotely. This is another means by which the case study institution ensures that student data remains private and secure even when shared between the university and students. The data indicated that the respondents could identify the general digital skills necessary to make use of VPN or other online safety platforms. *Basic digital skills* were the most significantly cited answer within the findings. Since basic digital skills includes an array of particular skills, participants may not be entirely sure as to the specific digital skills they need to operate a safety application.

Challenge 7: Student administration

As of part of iteration 2, participants were presented with the following challenge related to the online student administration activities.

"As a result of the pandemic many of the services UWC offers has been moved online. Some of these activities include online classes, registration, and electronic payments. However, students may still have challenges using these services or lack thereof."

All of the 15 students stated that at some point during the pandemic they had experienced challenges related to student administration. Altogether 15 of the respondents stated that this challenge could be addressed by making use of technological advancements. Respondents stated that certain manual and online processes could assist them with their student administration challenges. For example, the students stated,

"A place where all admin related queries can be solved. Instead of walking from one point to another. Maybe a platform where all queries can be logged and whoever is responsible can tend to the matter" (Case 5).

and

"UWC answering class and actually providing necessary information instead of having students call around to different depts hunting for information/assistance only to find out in the end that their issue still won't be resolved. In essence, a functional administrative system would be lovely" (Case 3).

and

"Knowing there's one point I can do all my tasks" (Case 9).

The respondents mentioned a variety of digital skills they need to complete administrative tasks online. For example, respondents stated,

"Transaction skills. Problem solving skills" (Case 4).

and

"Besides common digital literacy, also common skills related to computer and document usage." (Case 12).

and

"Document management, use of platforms, digital reading skills." (Case 2).

The researcher affirms that in order for a traditional campus community to transition to a smart campus environment, certain digital skills pertaining to student administration are required. The data indicated that students experience challenges related to online student administration at the case study institution. Moreover, the students understand that they need digital skills to manage their personal information online. The digital skills identified by the students include *digital literacy, computer skills, transaction skills, problem solving skills, application skills, document management*, and *digital reading skills.*

Challenge 8: Teaching and learning (e – Learning)

The respondents were presented with the following challenge related to the teaching practices at the case study institution. The following challenge was presented to the students,

"E-learning can be defined as an online platform where educational tools, material, and resources are shared between students and lecturers. Evidently, universities across the world are experiencing an increased demand for educational services. However, some university programmes do not allow for flexibility in terms of attendance. University rules require of a student to be present and accounted for during online and in person classes. "

93% of the respondents stated that they have had issues attending all their classes in person. In iteration 1 (pre-COVID-19), some of the respondents noted that traffic congestion, time management and financial strain were some of the challenges they experienced which led to them missing or being late for class. The respondents noted,

"Traffic in the morning otherwise good" (Case 1).

and

"The main issue was transport and time management issues" (Case 14).

and

"Financial assistance and easing access to transport" (Case 10).

During the pandemic, several students stated that household challenges and internet connection failures prohibited them from attending classes online. For example, the respondents noted,

"Since the pandemic I've been back home I think improvement of internet speed when attending online classes would have helped me" (Case 1).

and

"During the pandemic it has become increasingly difficult to keep up with classes at home" (Case 15).

10 out of 15 of the respondents agreed that a digital solution in the form of an e-learning platform could assist them to attend classes. The data indicated that the respondents list a diverse group of digital skills needed to solve the challenge mentioned above. The participants were presented with a digital solution aimed at providing a flexible, technologically advanced e-learning platforms to university students. The respondents noted the following digital skills they deemed necessary to make use of a smart e-learning platform,

"Critical thinking skills, you need to know how to use the platform to create solutions for your issues. Application skills – you need to know what tool to use when. Possibly data analysis skills. For instance, if a website captures your marks and generates and analysis you need to know how to analyse that information to assess where you in your course" (Case 15).

and

"Document management, digital communication, digital troubleshoot, digital etiquette" (Case 2).

and

"Computer literacy, Microsoft office and Cloud storage" (Case 6).

The researchers affirms that a traditional campus transitioning to a smart campus community needs to ensure that students have the necessary digital skills to function optimally using a smart e-learning system. The data indicates that students have trouble in terms of attending classes in person and online in real time. The researcher theorises that flexibility in terms of attending classes can resolve the issue. Students need to be able to attend classes presented by lecturers even if it is not at the stipulated time slots. Furthermore, the students understand that it is necessary to have basic digital literacy skills to navigate a smart e – learning platform. The

digital skills presented by the students are as follows, *Critical thinking skills, data analysis, application skills, document management, digital communication, digital troubleshoot, digital etiquette, computer literacy, Microsoft office* and *Cloud storage skills.*

Challenge 9: iKamva (LMS)

The respondents were presented with the following challenge related to iKamva as the primary learning management systems utilized by the case study institution.

"iKamva is a Learning Management System (LMS) used by UWC staff and students to facilitate the majority of online activities as related to course material. Students receive course resources from the lecturers, participate in forums and submit assignments. Navigation of this platform is a challenge for community members."

80% of the respondents noted that they agree that they find navigating functions of iKamva challenging. The respondents experienced various issues related to the functionalities, navigation, and response-time of iKamva. For example, the participants stated,

"Navigation to what I need to find to complete my work" (Case 1).

and

"Navigation around the site. Content is scattered around not properly structured, so students find it hard to find the exact content" (Case 3).

and

"Sometimes the website wouldn't be responsive. It'd big out" (Case 9).

and

"Sometimes we were unable to log on Ikamva or Ikamva would crash while we are on doing something. It happened while we were writing an online exam in 2018 and for my friend in 2020 during second semester" (Case 11).

14 out of 15 of the students responded "Yes" when asked if an updated learning management system would assist them to navigate the application. In iteration 1, the majority of the students listed the basic digital literacy skills necessary to navigate the new improved learning management system. For example, the respondents stated,

"Basic computer skills" (Case 3).

and

"User skills and basic digital lit skills. Problem solving skills" (Case 9).

and

"Application skills – understanding all the functions of the app. Computer fundamental skills – much of the data uploaded to Ikamva is via a computer. So, students need to know how to use a computer/laptop" (Case 15).

and

"Handling information" (Case 6).

In contrast to iteration 1, the responses from respondents in iteration 2 suggested much more advanced digital skills and digital strategies to ensure that they could make use of the platform effectively. For example, the respondents noted,

"Digital etiquette, how to communicate digitally, how to collaborate digitally, the role of communication platform within the suite of tools (example the integration with other tools to support the output task/objective" (Case 2).

and

"Knowing what functions would benefit me as a student and how I can use it to my advantage. Training related to functionalities on the app" (Case 5).

The researcher affirms that in order for a traditional campus to move towards becoming a smart campus community, the LMS has to be as user friendly as possible. The data indicates that respondents struggle to use the platform citing navigation on the platform and understating the functionalities of the platform, as the main challenges. Moreover, in iteration 1 students mentioned that *basic digital skills* could assist them to properly use the proposed updated iKamva platform. While a respondent in iteration 2 suggested *integration skills*, related to using tools on multiple platforms to achieve a set task. Additionally, a responded notably added a digital strategy aimed at knowing how to use the application to his/her advantage. Other digital skills mentioned by the participants include *digital etiquette* and *digital communication*. Much consideration has to be given to the fact that students experience challenges utilizing the current learning management system.

4.4.3 Discussion related to the Integration phase

Challenge 10: Innovative study areas

The students were presented with the following challenge related to innovative study areas as part of the online survey.

"The purposive use of ICT presents an opportunity for universities to enhance their learner's performance, learning capabilities and social interactions. Study areas are crucial to the productivity of students on campus. The majority of students use campus areas to study, work in teams, and tend to their individual assignments. Innovative study areas have the possibility to improve the learner's motivation and quality of life on campus."

12 out of 15 of the respondents agreed that the lack of innovative study areas on campus is in fact a challenge that students experience on campus. Similarly, 12 out of 15 believe that the case study institution currently lacks technologically advanced study areas.

In iteration 1, students were presented with an opportunity to list the types of technology they would like to have available in the innovative study areas. The data indicates that Cases 8, 9, 10 and 11, determined that the use of an "interactive whiteboard" would be an effective addition to the study spaces (see Appendix E). Other participants placed emphasis on the need for digital equipment, furniture arrangement, air control, and interior decoration of the innovative space. For example, the respondents stated,

"More digital devices in the study areas" (Case 2).

and

"Colourful bright spaced with interactive boards" (Case 7).

and

"Movable furniture" (Case 5).

In contrast, the respondents recommended an array of more advanced technologies to be included in the innovative study space during iteration 2. For instance, the respondents stated the following,

"Sensors to establish the best temperature for the environment. Facial recognition for attendance. AR VR tech to make study areas fun. Sleeping corners that automatically wake you after a few minutes sleep. Video game section" (Case 13).

and

*"A live *Siri or *Alexa to help you with you work. Say you are searching for data you can just ask Siri where you can find the proper source – and she helps. An online sport section*

where people can play cricket etc. using AR/VR. Fun creative spaces make it easier to study. When you're always trapped in the same space you feel demotivated after a while" (Case 5).

and

"Make more use of online platforms and cloud services as well as mobile applications" (Case 14).

Some of the respondents during iteration 1 noted that in part they do not know which digital skills they would need to function optimally within an innovative study space. For example, the respondents stated,

"I'm not sure what skills I would need" (Case 2).

and

"I don't know exactly what skills I would need" (Case 9).

and

"Not really sure what skills I would need to function in such an environment" (Case 10).

While the respondents in iteration 2 presented digital skills, they say they require to function within an innovative study space (see Appendix E). For example, the respondents stated,

"Digital philosophy, shared space etiquette, how to guides and walkthroughs, digital etiquette" (Case 2).

and

"I think there would be more advanced technology I would need more advanced digital skills such as data analysis, digital creation, innovation and critical thinking skills" (Case 8).

and

"The space many require more advanced digital skills. If the laptops/computers have new application loaded to assist students, we might need data analysis and integration skills. Integration to just know how to use a bundle of applications collectively to achieve a set result. Also, critical thinking skills will need to be applied." (Case 12).

The researcher affirms that a traditional campus transitioning to a smart campus community needs to incorporate smart study areas. Students need to have the necessary digital skills to function optimally in a smart study environment. The data indicates that the respondents agree that the case study institution does not have technologically advanced study areas. Moreover,

there is a perceived difference in iteration 1 and 2 regarding the recommendations shared by the respondents concerning the digital skills they require to function optimally in an innovative study space. In the first iteration the participants could not identify the necessary digital skills they would need to function optimally in an innovative study space. However, in iteration 2 the respondents mentioned new digital skills not found in DSF1. These digital skills include *integration skills, digital creation, digital philosophy, critical thinking skills* and *data analysis.* The data indicated that the respondents understood that more advanced digital skills would be necessary to operate any technologically advanced hardware, software, and programmes in an innovative study area.

Challenge 11: Health and wellness (Iteration 2)

The students were presented with the following challenge related to health and wellness services as part of the online survey. It is important to note that this challenge was only included during the second iteration, reason being the pandemic raised health concerns for the HE sector. The researchers wanted to assess the manner in which digital technology could aid or benefit students during these unprecedented times.

"COVID-19 has presented many challenges in the campus communities across all South African campuses. The health and wellness of employees and of students have taken front stage in in order to ensure that the campus community remains safe from immediate health threats."

86% of the respondents noted that they do have concerns returning to campus post-pandemic. The respondents noted that certain procedures need to be in place in order for them to feel confident returning to campus. For instance, the respondents noted the following measures should be taken by university management to ensure the safety of community members when returning to campus post-pandemic,

"Analytics on the spread of the virus. Live updates on the virus in the community" (Case 1).

and

"To abide by the guidelines set out by the government" (Case 9).

and

"A health tracking app" (Case 8).

and

"More people should get vaccinated" (Case 6).

93% of the respondents agree that returning to campus post-pandemic is in fact a challenge that students will experience. When presented with a health tracking application, students mentioned that they will require certain digital skills to make use of such a mobile application. The digital skills mentioned in the online survey included,

"Knowledge management, information dissemination, critical thinking" (Case 2).

and

"Application skills" (Case 15).

and

"Knowing how to use digital devices" (Case 6).

It should be noted that Cases 4, 5, 10, and 11 determined that "Basic digital skills" will be required to use a health monitoring application on campus.

The data indicated that students are particularly concerned about returning to the case study institution premises post-pandemic. Their fears can in part be solved by the case study institution continuing to follow the rules and regulations set out by the South Africa government. Furthermore, certain technological advancements were mentioned to improve the confidence of students returning to campus. These technologies include a health monitoring application and using data analytics to keep track of and present the spread of the virus on campus. Moreover, the respondents indicated that they require *basic digital skills* to make use of a health monitoring application. Whereas other respondents mentioned *knowledge management, critical thinking* and *application skills* as means of navigating the health monitoring application.

Challenge 12: Food services

The students were presented with the following challenge related to food services and food security as part of the online survey.

" Food security is a key aspect of any smart campus community. Food shortages and scarcity is a grave issue in our underprivileged communities in South Africa. It is critical to assess the research conducted concerning the availability of food on campus to ensure that daily needs of students and staff are met, and that sustainability of food supply and meal production is achieved."

80% of the respondents agreed that a lack of food services and food scarcity is an issue they have personally experienced on campus. The respondent noted a number of solutions to improve the current food services challenges on campus. For example, the respondents mentioned,

"More opportunities for others to provide food services to meet the needs of people on campus" (Case 1).

and

"An online map of food services would help" (Case 7).

and

"An application to show opening of new shops, specials and locations of shops" (Case 11).

The data further indicated that the respondents (Cases 3, 4, 6, 8, 9, and 10) mentioned "*An app*" would assist them with their food services challenges on campus. 13 out of 15 of the participants stated that technological advancements could assist them with their food services and food scarcity challenges. The students were presented with a technologically advanced means to provide solutions to their food services and food scarcity challenges. The technological advancements included a smart garden that incorporates smart equipment. Once the solution was presented the respondents stated which digital skills would be necessary to assist the students with their food services and scarcity challenges. For example, the respondents noted the following concerning the digital skills,

"It will be very exclusive skills, so we need specialised training for the specific equipment. Mostly related to agriculture" (Case 3).

and

"Since this is more related to sustainability, really monitoring your digital footprint while using this environmentally sustainable technology is important. We need to evaluate the impact we have on the land and air around us" (Case 8).

and

"A lot of students experience hunger on campus. A advanced farming initiative can really assist the students you grow the food themselves and feed the community. It will most likely be specialised equipment, therefore, use of application, critical thinking skills, problem solving skills, responsible use of hardware and software, creative skills" (Case 15).

The data indicated that the majority of students have experienced challenges related to food services and food scarcity on campus. The participants agree that this challenge can be solved by means of technological improvements. Some participants mentioned that they would require more *advanced digital skills* to operate the specialised smart agricultural equipment. These digital skills include measuring *digital footprint, critical thinking, etiquette* concerning the hardware and software of the smart technology and *creativity skills.*

4.4.4 Discussion related to the Transformation phase

Challenge 13: Sustainability

The participants were presented with the following challenge related to facial recognition as part of the online survey.

"The final step within the innovation process is the transformation phase. In this phase the foundational, core and integration services have been optimized and streamlined on campus using technology. However, it is important to note that this is an iterative process that requires those involved to always re-assess, re-test and monitor, and change processes within the previous phases if they are deemed outdated or irrelevant. The transformation section ensures that sustainable goals are met and that community members always look to establish growth within the community."

The findings indicate that 8 out of 15 of participants would accept facial recognition on campus while the remaining 7 out of 15 were apprehensive about implementing the technology. The participants noted a number of reasons for their disapproval of the technology. For example, respondents stated the following,

"I think it is an invasion of privacy. While I do understand that it could help with taking attendance and safety. I think we would be treating people like objects that need to be monitored. It takes the sense of freedom away from an individual" (Case 5).

and

"I don't think people should be monitored that severely. We all have a right to privacy" (Case 9).

and

"I do not trust the university to keep that server secure. Also, with students learning computer science on campus, I feel there will be lots of risk of students messing around with the systems. Most importantly, with deep fakes etc on the rise, if the university cannot

guarantee that data is protected over a period of time – which I believe it cannot do. Then this will always be a risk and infringement of privacy. If learning is tracked by facial recognition – it takes away from a learning environment as it creates an environment whereby you are being watched and tracked on your learning path which is a system traditional models are based on. This constricts the ability of a student to grow their love of a subject beyond what is expected. It also makes it feel like a prison rather than a life enriching activity and opportunity" (Case 2).

The participants in favour of the facial recognition technology noted the advantages the technology would bring to their experience on campus. For instance, the respondents noted,

"I would accept it. It makes life easier for the lecturer. Students and admin. Lecturers can monitor attendance. Students don't have to carry cards or lose cards. Admin can monitor movement for safety. They just shouldn't spy on us" (Case 4)

and

"I would accept facial recognition for class attendance for but not for movement as is it would be violating my right to privacy. I think monitoring of movement must be a voluntary choice as you are capturing something very personal. Exceptions could be made when a crime is being investigated however" (Case 7).

and

"Yes, I think it might be a powerful tool to benefit the lives of students. However, the university should take care not to be invasive in their approach. Not become authoritarian in student movement and individual decisions. People still need freedom to do what we want in the bounds of the law" (Case 15).

The participants further proposed the technology they would approve of being implemented on campus. The recommendation of technologies by the respondents was as follows,

"Connecting each student to a virtual assistant like Siri to help us with student admin issues and module queries" (Case 1).

and

"I think I would like to see more cameras, more safety digital interventions. Interactive whiteboards are cool but I think for our context, it may be a little too early for that. I think I would like to first see a layout change before the technologies are integrated. I would like to

see more hubs to quickly access internet etc. I would like to see more tech rooms with 3D printing and VR glasses that we are able to utilise as we would a book in the library. Lastly, I would like to be included on these decisions. I think more surveys and interviews should be done on campus. I feel the digital future can only be co-created and each year, the envisioned future changes. Therefore, I feel everything needs to be designed in a modular way to accommodate for incremental upgrades as technology becomes more accessible and useful. I would not like to see the university spend tons of money for all this new tech when it is still trying to solve the issue of data and devices for students. I feel that if students do not have a device and data - any of the tech recommendations will be a gross misallocation of capital and will visually perpetuate the digital divide we currently experiencing" (Case 2).

and

"Sustainable smart farming. Campuses should invest more in farming. Teaching young people how to use new technology to create a sustainable environment. Same can be said for water conservation" (Case 10).

and

"Biometric security systems" (Case 13).

The data indicates that nearly half (7 out of 15) of the participants are apprehensive about implementing facial recognition on campus premises. From the 7, many noted that the infringement of privacy is a major concern to them. Contrastingly, 8 out of 15 of the respondents noted that there they are in favour of facial recognition technology. They approve of the advantages the technology holds in store for them, their peers, and the broader community. The advantages include no need for student cards, no need for lecturers to take attendance registers, and improves safety within classrooms. The data indicated that while respondents understand the advantages that facial recognition technology could hold in store for them, they are apprehensive about the limits the technology would impose on their privacy.

4.4.5 Discussion related to stakeholder's role for digital skills development

Multiple stakeholder relationships play a key role in developing a smart campus community (Kolehmainen et al., 2016). It was thus important to establish where the students obtain their digital skills from and from that point onward establish if there are any other stakeholder groups and individuals who could supply these digital skills to students. The data indicated that respondents make use of various people and online resources to enhance their current digital skills. For example, some of the respondents stated,

"Most of the skilled were geared towards user skills. After first year the lecturers us navigate iKamva and any other application we needed for a module. I usually just use Youtube to help me out. Youtube has helped me with most of the questions I have when it comes to the use of an application" (Case 12).

and

"I did receive some training which was very foundational skills. They taught us how to create content, how to manage files on a computer, and basic training on iKamva. That was in first year. Afterwards, it was more the lecturer's responsibility to teach us certain skills. Like working on Pestel or using Excel for specific reasons. In postgrad I attended a few training sessions for Atlas.ti and Mendeley" (Case 11).

and

"I think as a postgrad student I've received a lot of assistance. The post-grad department really does a lot to assist students. Especially if you ask for help. I can't really remember taking any basic digital literacy classes while being undergrad, but I've received a lot of assistance from the Port-grad department. The have sessions where they teach you how to navigate an application, how to manage and store data safely, what the differences are in application usage. They regularly post their updates via UWC email" (Case 13).

One of the respondents mentioned that it is critical for students to be involved in the process of developing a smart campus community. The respondent stated the following,

"I think I would like to see more cameras, more safety digital interventions. Interactive whiteboards are cool, but I think for our context, it may be a little too early for that. I think I would like to first see a layout change before technologies are integrated. I would like to see more hubs to quickly access the internet etc. I would like to see more tech rooms with 3d printing and VR glasses that we are able to utilize as we would a book in the library. Lastly, I would like to be more included on these decisions. I think more surveys and interviews should be done on campus. I feel the digital future can only be co-created. and each year, the envisioned future changes. Therefore, I feel everything needs to be designed in a modular way to accommodate for incremental upgrades as technology becomes more accessible and useful" (Case 2).

In the view of the participants lecturers played a crucial role in developing their digital skills. The data indicated that lecturers assisted students to learn new digital skills to navigate the

applications they used for specific modules. Moreover, self - study and online resources gave students the opportunity to learn digital skills based on their needs pertaining to specific modules. Additionally, co-designing, as mentioned by one of the respondents, can be used as a measure to involve the student in the planning, design, testing, and implementation phases of an innovation project in an HE community transitioning from a traditional campus environment to a smart campus environment.

4.5 Synopsis of discussion

The researcher deduced the following from the findings presented above. Students transitioning from a traditional campus need the necessary basic digital skills to function optimally and productively in an innovative environment. The basic digital skills the respondents identified as being adequately skilled at included *problem solving, handling information, transacting* and *personal life skills*. The basic digital skills the respondents were least equipped with included *communication* and *content creation skills*. Subsequently, by proposing 13 challenges to respondents, an array of new digital skills was presented by the participants to solve HE campus related challenges. The researchers added additional digital skills to the proposed framework (see Section 4.6). Lecturers have been identified as key stakeholders to supply digital skills to students. Therefore, it is imperative for lecturers to be equipped with the necessary digital skills themselves in order to transfer the digital skills to their students. In essence, the findings indicate that an HEI can only transition to a smart campus community as fast and effectively as students and lecturers are digitally equipped to manage and operate the technological advancements in the smart campus environment.

4.6 Chapter summary

Chapter 1 presented the background information and research objectives related to this study. The research objectives including verifying the digital skills necessary to function in smart campus community and verifying the stakeholders necessary to supply the digital skills, have been attained. Furthermore, the key components of Chapter 3 were considered in order to facilitate the data collection process. These elements included the research philosophy, sampling method, data analysis techniques and ethical considerations.

The need for basic digital skills in an HE community transitioning from a traditional campus environment to a smart campus community has been established. Participants agreed that HE communities face certain challenges when transition to a smart campus community. Moreover, the respondents noted that they require digital skills to ensure that they have the capabilities to

solve the challenges associated with the transition. The additional digital skills necessary to function productively in a smart campus environment were presented also by the respondents in iteration 2. Thereafter, the researchers amended the framework (see the original framework from the literature in Section 2.9) to incorporate the respondents' insights during iteration 1 and 2 into the digital skills development framework. Table 18 illustrates the verification of the digital skills required by students to function optimally is a smart campus environment. The digital skills were identified by the respondents. These verified digital skills are highlighted in green. The list of basic digital skills and user skills are highlighted in blue. Additionally, the stakeholder groups and individuals responsible for supplying digital skills to HE community members were verified based on the inputs of the respondents. These verified stakeholders are highlighted in green. Moreover, the additional stakeholders that supplied the digital skills to the community members (students) were identified and added to the framework. The additional stakeholders identified by the students are highlighted in light blue. Finally, the digital skills and stakeholders that were not verified based on the respondents' insights are highlighted in red. Table 17 is key to differentiate between the different verified and unverified digital skills and stakeholders.

The following and final chapter will give a summary of the key findings of this study, present the achievement of each objective, and establish if validity and reliability were upheld. Finally, there will be a consideration of the limitations of the study, recommendations for future research, and a discussion of the contribution this study makes to the current body of knowledge.

Table 17: Key to comprehend Table 18

KEY	
Verified skills	Green
Verified stakeholders	Green
New skills presented by students	Blue
New stakeholders presented by students	Blue
Non verified skills	Red
Non stakeholders	Red

Table 18: Proposed digital skills development framework

No	Challenges	Skills related to challenge from literature (DSF1) and participants	Skills-stakeholder links from Quadruple Helix and participants responses	Literature	Stakeholders responsible for different phases in a maturing HE community
1	**Access to digital devices**	• Problem solving • Transacting • Work and learning	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arnkil, Järvensivu, Koski & Piirainen (2010); Carayannis and Campbell (2011); Katunga, Njenga, Craffert, van Audenhove & Marien (2019), Kolehmainen, Irvine, Stewart, Karacsonyi, Szabó, Alarinta and Norberg (2016)	**Phase 1:** **University – (Lecturers and Post graduate Services)** **Industry – (Online resources)** **Community – (Students)**
2	**Access to internet connectivity**	• Transacting • Problem solving	• Universities • Industry • Intermediaries • Government	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	

3	**Digital skills**	• Communication • Managing information • Transacting online • Problem solving • Work and learning • Content creation • Personal life • Text processing • Spreadsheets • Presentation • Web surfing • Privacy • Security • Cloud services • Collaboration • Social media • Ethical behaviour online	• Universities - Post graduate services- Lecturers • Industry - Online resources • Intermediaries • Community - Students (Self-study)	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	
4	**On and off - site mobility**	• Communication and collaboration • Problem solving • Managing information • Transacting online • Work and learning • Critical thinking • Mobile fundamental skills	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al., (2016); Katunga et al., (2019)	
5	**Physical safety of students**	• Problem solving • Ethical behaviour online • Communication • Critical thinking • Data analysis Application skills	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	**Phase 2:** **University (Lecturers)** – **Community (Students)** –

6	**Data privacy**	• Online etiquette • Managing information • Transacting Problem-solving Personal life • Understanding cookies • Navigating VPN services	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	
7	**Student administration**	• Online etiquette • Managing information • Transacting • Problem-solving Personal life • Online document management • Digital reading • Application skills	• Universities • Industry Intermediaries • Community	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	
8	**Teaching and Learning initiatives**	• Communication and collaboration • Managing information • Transacting online • Problem solving • Work and learning • Content creation • Personal life • Text processing • Spreadsheets • Presentation • Web surfing • Cloud storage • Computer literacy • Digital troubleshoot • Online document management • Critical thinking	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	

9	**iKamva (LMS)**	• Online etiquette • Communication and collaboration • Managing information • Transacting online • Problem solving • Work and learning • Content creation • Personal life • Text processing • Spreadsheets • Presentation • Web surfing	• Universities • Industry • Intermediaries • Community-Students (Co-design)	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	
10	**Lack of innovative spaces**	• Communication and collaboration • Managing information • Transacting online • Problem solving • Work and learning • Content creation • Personal life • Text processing • Spreadsheets • Presentation • Web surfing • Advanced digital skills • Digital philosophy • Digital creation • Critical thinking • Integration • Data analysis	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	**Phase 3:** **University – Community (Students)**
11	**Health and Wellness**	• Managing information • Transacting • Problem-solving • Personal life • Knowledge management • Information dissemination • Critical thinking	• Universities • Industry • Intermediaries	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	

12	**Food security**	• Managing information • Transacting • Problem-solving Personal life • Advanced digital skills • Measuring digital footprint • Critical thinking	• Universities • Industry • Intermediaries • Government	Skills: Claassen (2017) Stakeholders: Arkin et al. (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	
13	**Sustainability**	• Communication and collaboration Managing information • Transacting online • Problem solving • Work and learning • Content creation • Personal life	• Universities • Industry Intermediaries • Government • Community - Students (co-design)	Skills: Claassen (2017) Stakeholders: Arkin et al., (2010); Carayannis and Campbell (2011); Kolehmainen et al. (2016); Katunga et al. (2019)	**Phase 4:** **University** **Community – (Students)**

Chapter 5: Conclusions and Recommendations

5.1 Introduction

The researchers set out to answer the following research question, "What are the digital skills required for Higher Education communities to transition from traditional campuses to smart communities?". In her quest to answer the research question, a problem statement was developed to guide the researchers as to the particulars within the study that had to be addressed. The problem statement was as follows, "Universities face different challenges transitioning from a traditional HE community to a smart HE community. These challenges can be addressed through developing a framework to address the underlying digital skills shortcomings in HE communities. Universities are yet to create a framework describing the lack of basic and advanced digital skills in their communities as it relates to a move towards becoming smart communities". An exploratory research process was incorporated that used a mixed-methods approach to gather both quantitative and qualitative data. A Living Labs methodology was followed, 15 respondents gave replies to questions that were posed in 2 iterations in order to gather rich insights from respondents. This methodology was followed to collect feedback from participants and make adjustments to the framework by presenting the questions to the respondents a second time. An online survey was used as it was an appropriate data collection method to gather rich insights from the respondents.

5.2 Summary of research findings

The findings indicated that students transitioning from a traditional campus need the necessary basic and advanced digital skills to function optimally and productively in an innovative environment. Respondents noted that the basic digital skills they were sufficiently equipped with include *problem solving, handling information, transacting* and *personal life skills*. The basic digital skills respondents noted they were least equipped with include *communication* and *content creation skills*. Additionally, the respondents stated that the skills training they have received was predominantly geared towards user skills rather than basic digital skills. A variety of new digital skills was presented by the participants to enable them to function optimally in a smart campus environment. The findings indicated that the respondents were able to establish the digital skills necessary to solve the majority of the 13 challenges presented to them. Additional digital skills presented by the respondents were added to the proposed framework (see Section 4.6). Institutionally, lecturers have been identified as key stakeholders

to supply digital skills to students. Therefore, it is imperative for lecturers to be equipped with the necessary digital skills in order to transfer the digital skills to their students.

In summary, the findings indicate that an HEI can only transition to a smart campus community as fast and effectively as students and lecturers are digitally equipped to manage and operate the technological advancements in the resulting smart campus environment.

5.3 The attainment of the research objectives

Certain objectives were established to answer the research question. Each of the objectives was achieved by means of researching the current body of knowledge and collecting primary data. The first objective namely, "To define from literature and previous research, the challenges experienced by higher education communities moving from a traditional campus to a smart campus community.", was reached by researching and extracting information from the current body of knowledge. A number of traditional HE challenges were identified throughout literature. Once the researcher had identified the challenges, the second objective followed.

The 2nd objective, namely, "To define from literature the digital skills needed to solve smart campus related challenges", was reached by consulting previous research related to the digital skills necessary to function optimally within a smart community. The researchers identified the Digital Skills Framework (One) as it incorporated the basic digital skills and user skills necessary to be a functional and productive digital citizen in today's society. DSF1 was used as a guide to discover firstly, whether the respondents possessed the digital skills mentioned in the framework and thereafter determine if they needed additional digital skills that could solve their challenges on campus. Once DSF1 was incorporated in the study, the third objective followed.

Objective 3, namely, "To verify from end user engagement which digital skills are related to which challenges", was reached by involving 15 respondents in an online survey. The survey included both open-ended and closed-ended questions to gain valuable insights into the perception of the respondents. Firstly, the researcher established what digital skills the participants currently possess. This was achieved by incorporating a Likert scale for responses to questions related to DSF1. The data indicated that the particular use of basic digital skills such as *problem solving, handling information, transacting,* and *basic digital skills* related to personal life, were saturated as a majority of the respondents reported that they already

possessed these basic digital skills. However, basic digital skills related to *communication and content creation* presented areas in which participants were least confident. The students established a number of new digital skills that should be taken into account when a traditional campus environment seeks to transition to a smart campus environment. The digital skills mentioned below come from the responses from the participants who had been asked about the challenges they had experience on campus. Particular questions gave the respondents the opportunity to share their insight into the specific digital skills they thought would be required to solve each of the challenges. The nuanced digital skills identified by the students that could aid them to be productive community members within a smart campus environment were, *"critical thinking", "data analysis", "digital reading skills", "digital troubleshoot", "shared space etiquette", "application skills", "digital philosophy", "digital creation", "integration skills", "knowledge management", "information dissemination"* and *"digital creativity skills".* Once the digital skills were determined, the final objective could be reached.

The 4th objective, namely, "To verify from end user engagement the stakeholders with critical responsibilities for the development of the identified digital skills", this was achieved by extracting relevant data from the participants. The relevant data was related to where the participants received the digital skills training. The participants mentioned that while they received digital skills training at the case study institution in the first year of their studies, the majority depended on online resources, lecturers, post graduate departmental services, and self-study to upskill themselves. Numerous participants mentioned the importance of the lecturers during the process of acquiring new digital skills. The data indicated that the role of a lecturer was crucial in supplying digital skills to students in an HE community transitioning towards a smart campus community.

Within phase 1 of the roadmap to a smart campus environment, university management plays a critical role by providing the foundational digital skills to students. If the research institution fails to take responsibility in this regard, the university will struggle to transform to a smart campus community. Phases 2 and 3 rely on the aptitude and willingness of the lecturers to provide digital skills to students. In the case of lecturers being poorly equipped with digital skills, students will not be able to transition smoothly into a smart campus environment. If this is the case, students in a transitioning HE community will ultimately fall behind or find it challenging to adapt to a smart campus environment. Finally, according to literature the stakeholders responsible for supplying digital skills, in the fourth phase relies on a multitude of role-players including university management, lecturers, and students (co-design capacity).

5.4 Measures implemented to establish validity and reliability of the study

5.4.1 Validity of the mixed methods approach

Validity and reliability were critical components within the research process as they established and ensured the quality of the research conducted. Firstly, internal validity, otherwise known as measurement validity, was established by implementing a participatory and collaborating mode of research. This mode of research allowed the researcher to include numerous individuals in specific phases of the researcher process to strengthen the validity of the research instrument and the interpretations of the research findings (Zohrabi, 2013). The researchers collaborated with two UWC doctorate alumni specialising in the field of Information Systems, to gather their insights into the type of instrument the researcher should use, the manner in which the journey from a traditional campus to a smart campus community should be presented and the questions the researcher should be presented to the participants. The insights of the two experts proved valuable as the research instrument and questions used in this study allowed the researcher to gain important insights from the respondents (see Section 3.5.1).

Content validity was achieved by allowing an expert to review the literature, research process, and online survey questions presented to the respondents. Chapters 1, 2 and 3 were frequently submitted for review. In addition, the online survey was reviewed by an expert to ensure that the survey questions were accurate and unbiased. The reviewer was a lecturer that holds a PhD in the field of Information Systems. The constructive criticism received from the expert proved to be valuable and further attributed to the content validity of the research (see Section 3.5.1).

Lastly, face validity was achieved since the date collected was accurate. The questions asked to the participants in the online survey were easy to comprehend. A pilot test was issued to four individuals to establish whether the question in the survey was easy to comprehend, unbiased and posed a logical flow. The pilot test was issued to colleagues and peers. The pilot test participants work in the field of Information Systems and are familiar with the concepts pertaining to smart communities and digital skills. The comments shared by the participants in the pilot test proved necessary and valuable as the researchers could amend the questions to create a comprehensive and logical flow of the question in the online survey (see Section 3.5.1).

5.4.2 Reliability of the mixed methods approach

While reliability can be described as the ability of the research conducted to be replicated within other studies (Saunders et al., 2019). The researcher implemented an audit trail to ensure that the dependability of data collection was achieved. The purpose of the audit trail to monitor

and record all changes made during the research process. This allowed the researchers to create a reliable account of the research conducted and the possibilities for future research. The audit trail proved necessary and valuable since the researchers could keep track and record key components in the research process and thereby ensuring the reliability of the study (see Section 3.5.2).

5.5 Contribution of research

By achieving the objectives mentioned above the researcher could answer the research question. Current digital skills that respondents possess and the additional digital skills they will require to function optimally in a smart campus community were noted. The researchers established that a traditional higher education community can only successfully transition to a smart campus community if the digital skills development of its community members is incorporated in each phase of the innovation process. The contribution this study makes to the current body of knowledge is by sharing a framework to assist the HE sectors in South Africa to acknowledge the digital skills required when transitioning from a traditional campus environment to a smart campus environment. The transition of South African HE communities to smart campus communities is but in its infancy. The researchers designed this skills development framework to guide South African HEI's through the process of smart campus development by placing an emphasis on the community members' abilities to solve campus related challenges through the use of digital skills.

5.6 Limitations of the study

Initially, the researcher proposed conducting face-to-face focus group sessions with the participants. The objective of the in-person focus group sessions was to gain rich insight, detailed arguments, and perceptions through the reactions and interaction of the participants. However, due to the implications of the COVID-19 pandemic, the researchers changed the data collection method to an online survey. Difficulties arose when trying to establish the correct line of questions and whether the participants understood the questions properly. Fortunately, after iteration 1, some questions could be adjusted in order to ensure the participants understood what was asked of them. Another limitation concerning the respondents' answers to the questions posed, was the fact that students had a perceived inability to identify the additional digital skills necessary to function productively in a smart community environment. Only limited data was collected concerning the stakeholder's involvement in the innovation process of a traditional campus transitioning into a smart campus community. The role and responsibilities that multiple stakeholders and stakeholder groups have in supplying the digital

skills to HE community members is a critical aspect that could not be addressed in its entirety. Lastly, 15 participants were selected to form part of the iterative data collection process. All the participants were current and former students studying at the case study university. Thus, the study's findings could not be generalised to establish the basic digital skills necessary to function optimally in a smart HE community, at the other South African HEI's.

5.7 Recommendations for future research

The question surrounding the supply of digital skills to a HE community is a vague area that has not been fully addressed in IS research. The researcher motivates that in order to clarify this area of uncertainty, more stakeholders from a range of different sectors should be incorporated as part of the sample of the study. The addition of multiple stakeholders in the data collection process could determine the key role-players responsible for supplying digital skills to a digitally transitioning HE community. A focus group session can prove valuable as a means to gain as much insight as possible into the digital skills required by community members in a smart campus community and to delineate the responsibilities of those required to supply those digital skills. Finally, the research was only conducted at the case study intuition. An opportunity exists for the study to be replicated at other South Africa HE communities.

6 References

Afonso, O., Monteiro, S. & Thompson, M. 2012. A growth model for the quadruple helix. *Journal of Business Economics and Management*. 13(5):849–865. DOI: 10.3846/16111699.2011.626438.

Aldowah, H., Rehman, S.U., Ghazal, S. & Umar, I.N., 2017, September. Internet of Things in higher education: a study on future learning. In *Journal of Physics: Conference Series*. 892(1):12017. IOP Publishing.

Al-Fraihat, D., Joy, M. & Sinclair, J., 2017, June. Identifying success factors for e-learning in higher education. In *International conference on e-learning*. 247-255. Academic Conferences International Limited.

Al-Fraihat, D., Joy, M. & Sinclair, J., 2020. Evaluating E-learning systems success: An empirical study. *Computers in Human Behavior*, *102*:67-86. DOI: doi.org/10.1016/j.chb.2019.08.004.

Alghamdi, A. & Shetty, S. 2016. Survey: Toward A Smart Campus Using the Internet of Things. In *2016 IEEE 4th International Conference on Future Things and Cloud*. IEEE. 235–239. DOI: 10.1109/FiCloud.2016.41.

Al-Janabi, S., 2020. Smart system to create an optimal higher education environment using IDA and IOTs. *International Journal of Computers and Applications*, *42*(3), 244-259.DOI: doi.org/10.1080/1206212X.2018.1512460.

Al-Kilani, M. & Kobziev, V., 2016. An Overview of Research Methodology in Information System (IS). *Open Access Library Journal*. 3(11):1-9.

Allam, Z. & Dhunny, Z.A., 2019. On big data, artificial intelligence and smart cities. *Cities*, 89:80-91. DOI: 10.1016/j.cities.2019.01.032

Allwinkle, S. & Cruickshank, P. 2011. Creating Smart-er Cities: An Overview. *Journal of Urban Technology*. 18(2):1–16. DOI: 10.1080/10630732.2011.601103.

Alshamrani, A. & Bahattab, A., 2015. A comparison between three SDLC models waterfall model, spiral model, and Incremental/Iterative model. *International Journal of Computer Science Issues (IJCSI)*, 12(1):106.

Al-Samarraie, H., Teng, B.K., Alzahrani, A.I. & Alalwan, N., 2018. E-learning continuance satisfaction in higher education: a unified perspective from instructors and students. *Studies in higher education*, *43*(11):2003-2019. DOI: /doi.org/10.1080/03075079.2017.1298088.

Anthopoulos, L. & Fitsilis, P. 2010. From Digital to Ubiquitous Cities: Defining a Common Architecture for Urban Development. In *Sixth International Conference on Intelligent Environments.* IEEE. 301–306. Available: http://www.bev.net [2021, June 13].

Arndt, C., Davies, R., Gabriel, S., Harris, L., Makrelov, K., Robinson, S., Levy, S., Simbanegavi, W., van Seventer, D. & Anderson, L., 2020. Covid-19 lockdowns, income distribution, and food security: An analysis for South Africa. *Global Food Security*. 100410. DOI: doi.org/10.1016/j.gfs.2020.100410.

Arnkil, R., Järvensivu, A., Koski, P. & Piirainen, T., 2010. Exploring the quadruple helix. Report of quadruple helix research for the CLIQ project.

Avgerou, C., 2003. The link between ICT and economic growth in the discourse of development. In Organizational information systems in the context of globalization. 373-386. Springer, Boston, MA.

Avgerou, C. 2008. Information systems in developing countries: A critical research review. *Journal of Information Technology*. 23(3):133–146. DOI: 10.1057/palgrave.jit.2000136.

Avgerou, C. & Walsham, G. 2017. *Information Technology in Context: Studies from the Perspective*. Routledge. Available: https://books.google.co.za/books?hl=en&lr=&id=DFM8DwAAQBAJ&oi=fnd&pg=PT7&dq=Avgerou,+C.+and+Walsham,+G.+eds.,+2017.+Information+technology+in+context:+Studies+from+the+perspective+of+developing+countries.+Routledge.&ots=LqRwsM6dYz&sig=JBRS0Su0MdWh0TOps8T22uBydxY&redir_esc=y#v=onepage&q=Avgerou%2C%20C.%20and%20Walsham%2C%20G.%20eds.%2C%202017.%20Information%20technology%20in%20context%3A%20Studies%20from%20the%20perspective%20of%20developing%20countries.%20Routledge.&f=false [2021, June 13].

Baheti, R. & Gill, H., 2011. Cyber-physical systems. The impact of control technology, 12(1):161-166.

Bakıcı, T., Almirall, E. & Wareham, J. 2013. A Smart City Initiative: The Case of Barcelona. *Journal of the Knowledge Economy*. 4(2):135–148. DOI: 10.1007/s13132-012-0084-9.

Balaji, S. & Murugaiyan, M.S., 2012. Waterfall vs. V-Model vs. Agile: A comparative study on SDLC. *International Journal of Information Technology and Business Management*, 2(1):26-30.

Barab, S. & Squire, K., 2004. Design-based research: Putting a stake in the ground. The journal of the learning sciences, 13(1):1-14.

Baskerville, R.L. & Myers, M.D., 2015. Design ethnography in information systems. *Information Systems Journal*, 25(1):23-46. DOI: 10.1111/isj.12055. Wiley Publishing Ltd.

Baskerville, R., Baiyere, A., Gregor, S., Hevner, A. & Rossi, M., 2018. Design science research contributions: Finding a balance between artifact and theory. Journal of the Association for Information Systems, 19(5):3. DOI:10.17705/1jais.00495.

Bătăgan, L. 2011. Smart Cities and Sustainability Models. *Informatica Economica*. 15(3):80–87.

Batty, M., Axhausen, K.W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G. & Portugali, Y. 2012. Smart cities of the future. *The European Physical Journal Special Topics*. 214(1):481–518. DOI: 10.1140/epjst/e2012-01703-3.

Bergvall-Kåreborn, B., Eriksson, C.I., Ståhlbröst, A. & Svensson, J. 2009. A Milieu for Innovation-Defining Living Labs. In *ISPIM Innovation Symposium*.

Bifulco, F., Tregua, M. & Amitrano, C.C., 2014. Living labs for smart innovation: a user-centric approach. The Human Side of Service Engineering, 1:282-294.

Billon, M., Marco, R. & Lera-Lopez, F. 2009. Disparities in ICT adoption: A multidimensional approach to study the cross-country digital divide. *Telecommunications Policy*. 33(10–11):596–610. DOI: 10.1016/j.telpol.2009.08.006.

Biswas, K. & Muthukkumarasamy, V., 2016, December. Securing smart cities using block chain technology. In High Performance Computing and Communications. *IEEE 14th International Conference on Smart City*. 1392-1393. IEEE.

Blanche, M.T., Durrheim, K. & Painter, D., 2006. *Research in practice.* Cape Town. University of Cape Town Press.

Blanco-Portela, N., Benayas, J., Pertierra, L.R. & Lozano, R., 2017. Towards the integration of sustainability in Higher Education Institutions: A review of drivers of and barriers to organisational change and their comparison against those found of companies. *Journal of Cleaner Production, 166*:563-578. DOI: 10.1016/j.jclepro.2017.07.252.

Bond, M., Marín, V.I., Dolch, C., Bedenlier, S. & Zawacki-Richter, O. 2018. Digital transformation in German higher education: student and teacher perceptions and usage of digital media. *International Journal of Educational Technology in Higher Education*. 15(1):1–20. DOI: 10.1186/s41239-018-0130-1.

Bongomin, O., Ocen, G., Nganyi, E., Musinguzi, A. & Omara, T., 2020. Exponential disruptive technologies and the required skills of industry 4.0. *Journal of Engineering*, 2020:1-17: DOI: 10.1155/2020/4280156.

Borghys, K., van der Graaf, S., Walravens, N. & Van Compernolle, M., 2020. Multi-Stakeholder Innovation in Smart City Discourse: Quadruple Helix Thinking in the Age of "Platforms". Front. Sustain. Cities, 2(5).

Bornman, E. 2016. Information society and digital divide in South Africa: results of longitudinal surveys. *Information, Communication & Society*. 19(2):264–278. DOI: 10.1080/1369118X.2015.1065285.

Botta, A., de Donato, W., Persico, V. & Pescapé, A. 2015. Integration of cloud computing and Internet of Things: A survey. *Future generation computer systems*. 56:684–700. DOI: 10.1016/j.future.2015.09.021.

Bradley, D., Noonan, P., Nugent, H. & Scales, B., 2008. Review of Australian higher education: Final report.

Broton, K.M., Weaver, K.E. & Mai, M., 2018. Hunger in higher education: experiences and correlates of food insecurity among Wisconsin undergraduates from low-income families. *Social Sciences, 7*(10):179. DOI:10.3390/socsci7100179

Brown, A., 2014. The place of ethnographic methods in information systems research. International Journal of Multiple Research Approaches, 8(2):166-178. DOI: https://doi.org/10.1080/18340806.2014.11082058

Buckingham, 2010. Defining digital literacy. *In Medienbildung in neuen Kulturräumen VS Verlag für Sozialwissenschaften.* 59-71.

Burrell, G & Morgan, G., 2005. Sociological Paradigms and Organisational Analysis. Abingdon: Routledge (originally published by Heinemann 1979).

Calder, K. 2016. *Singapore: Smart City, Smart State*. Brookings Institution Press. Available: https://books.google.co.za/books?hl=en&lr=&id=0tuACwAAQBAJ&oi=fnd&pg=PT7&dq=Calder,+K.E.,+2016.+Singapore:+Smart+city,+smart+state.+Brookings+Institution+Press&ots=-PtuyUm99x&sig=-iilMm-z-uKdwTvNwhnbpXgz_o0&redir_esc=y#v=onepage&q&f=false [2021, June 08].

Caragliu, A., del Bo, C. & Nijkamp, P. 2013. Smart cities in Europe. *Journal of urban technology.* 18(2):1-15.

Carayannis, E. & Campbell, D.F.J. 2009. “Mode 3” and “Quadruple Helix”: toward a 21st fractal innovation ecosystem. *International Journal of Technology Management*. 46(3–4):201–234. DOI: 10.1504/IJTM.2009.023374.

Carayannis, E.G. & Campbell, D.F.J. 2010. Triple helix, Quadruple helix and Quintuple helix and how do Knowledge, Innovation and the Environment relate to Each other? a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. *International Journal of Social Ecology and Sustainable Development*. 1(1):41–69. DOI: 10.4018/jsesd.2010010105.

Carayannis, E.G. & Campbell, D.F., 2011. Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: building on the quadruple and quintuple helix innovation concepts and the “mode 3” knowledge production system. *Journal of the Knowledge Economy.* 2(3):327.

Carretero, S., Vuorikari, R. & Punie, Y., 2017. DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use (No. JRC106281). Joint Research Centre (Seville site).

Castells, M. 1997. An introduction to the information age. *City*. 2(7):6–16.

Castells, M. & Blackwell, C. 1998. The information age: economy, society and culture. *Environment and Planning: Planning and Design*. 1:631–636. Available: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.457.4928&rep=rep1&type=pdf [2021, June 13].

Chourabi, H., Walker, S., Gil-Garcia, J.R., Mellouli, S., Nahon, K., Pardo, T.A. & Scholl, H.J. 2012. Understanding Smart Cities: An Integrative Framework. In *45th Hawaii International Conference on System Sciences*. 2289–2297. DOI: 10.1109/HICSS.2012.615.

Chuling, L., Zanfu, X. & Peng, P. 2009. A discussion on the framework of smarter campus. In *3rd International Symposium on Intelligent Information Technology Application, IITA 2009*. V. 2. IEEE. 479–481. DOI: 10.1109/IITA.2009.208.

Claassen, W. 2017. *Digital Skills Framework One – A comprehensive digital skills framework and Digital Literacy Framework (DLF)*. CoLab for e-Inclusion and Social Innovation. University of the Western Cape.

Coiera, E., 2009. Building a national health IT system from the middle out. *Journal of the American Medical Informatics Association,* 16(3):271-273.

Corporate Finance Institute. 2020. *Microsoft Excel Definition*, https://corporatefinanceinstitute.com/resources/excel/study/excel-definition-overview/ [10 March 2020].

Correa, T., 2016. Digital skills and social media use: how Internet skills are related to different types of Facebook use among ‘digital natives’. *Information, Communication & Society*, 19(8):1095-1107.

Couclelis, H. 2004. The construction of the digital city. *Environment and Planning B: Planning and Design*. 31(1):5–19. DOI: 10.1068/b1299.

Cunningham, J.A., Menter, M. & O’Kane, C. 2018. Value creation in the quadruple helix: a micro level conceptual model of principal investigators as value creators. *R and D Management*. 48(1):136–147. DOI: 10.1111/radm.12310.

Czerniewicz, L. & Brown, C. 2010. Born into the Digital Age in the south of Africa: the reconfiguration of the "digital citizen" Emerging Impact of Open Data in Developing Countries (phase 1) View project. In *In Proceeding of the 7th International Conference on Networked Learning*. 859–865. Available: https://www.researchgate.net/publication/228705449 [2021, June 10].

Daniel, S.J. 2020. Education and the COVID-19 pandemic. *Prospects: Comparative Journal of Curriculum, Learning, and Assessment*. 49(1–2):91–96. DOI: 10.1007/s11125-020-09464-3.

Das, K. 2019. The Role and Impact of ICT in Improving the quality of education. *International Journal of Innovative Studies in Sociology and Humanities (IJISSH) The Role and Impact of ICT in Improving the Quality of Education: An Overview*. 4(6):97–103. Available: www.ijissh.org [2021, June 13].

Davis, W.S. & Yen, D.C. eds., 2019. The information system consultant's handbook: *Systems analysis and design*. CRC press.

Deloitte. 2015. *Smart Cities – A Deloitte point of view*. GovLab

De Vaus, D. 2002. Analyzing social science data: 50 key problems in data analysis. Sage.

Díaz, M., Martín, C. & Rubio, B. 2016. State-of-the-art, challenges, and open issues in the integration of Internet of things and cloud computing. *Journal of Network and Computer Applications*. 67:99–117. DOI: 10.1016/j.jnca.2016.01.010.

Dowling, R., McGuirk, P. & Gillon, C., 2019. Strategic or piecemeal? Smart city initiatives in Sydney and Melbourne. *Urban Policy and Research*, 37(4):429-441. DOI: 10.1080/08111146.2019.1674647

Economic Intelligence Unit. 2018. *Automation Readiness Index*. Available at: https://www.automationreadiness.eiu.com/static/download/PDF.pdf [Accessed: 14 August 2019]

Ergazakis, K., Metaxiotis, K. & Psarras, J. 2004. Towards knowledge cities: Conceptual analysis and success stories. *Journal of Knowledge Management*. 8(5):5–15. DOI: 10.1108/13673270410558747.

Ergazakis, K., Metaxiotis, K. & Psarras, J., 2004. Towards knowledge cities: conceptual analysis and success stories. *Journal of knowledge management*. 8(5):5-15.

Etikan, I., Musa, S.A. & Alkassim, R.S., 2016. Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*. 5(1):1-4.

Etzkowitz, H. & Leydesdorff, L., 1995. The Triple Helix--University-industry-government relations: A laboratory for knowledge based economic development. *EASST review*. 14(1):14-19.

Etzkowitz, H. & Leydesdorff, L., 2000. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research policy*. 29(2):109-123.

Etzkowitz, H. & Ranga, M., 2015. Triple Helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. *In Entrepreneurship and knowledge exchange*. 117-158. Routledge.

European Commission, A.: Digital Agenda for Europe (2010), http://ec.europa.eu/information_society/digital-agenda/index_en.htm (retrieved September 20, 2014)

European Commission. 2011. Empowering People, Driving Change: Social Innovation in the European Union. Luxembourg: Publications of the European Union.

European Commission. 2012. 'Exploiting the Employment Potential of ICTS. Commission Staff Working Document Accompanying the Communication from the Commission to the European Parliament, the Council, the European Social and Economic Committee and the Committee of the Regions, SWD (2012) 96 Final', http://www.filling-the-gaps.eu/SWD_exploiting_the_ employment_potential_of_ICTs.pdf.

European Commission. European 2020 Index. Retrieved from ec.europa.eu/regional_policy/what/europe2020/index_en.cfm.

Evans, O. 2018. Connecting the poor: the internet, mobile phones and financial inclusion in Africa. *Digital Policy, Regulation and Governance*. 20(6):568–581. DOI: 10.1108/DPRG-04-2018-0018.

Finlay, B. & Agresti, A., 1986. Statistical methods for the social sciences. Dellen.

Fitzpatrick, G. & Malmborg, L., 2018, September. Quadruple helix model organisation and tensions in participatory design teams. *In Proceedings of the 10th Nordic Conference on Human-Computer Interaction*. 376-384.

Flynn, J., Dance, S. and Schaefer, D., 2017. Industry 4.0 and its potential impact on employment demographics in the UK. Adv. *Transdiscipl. Eng*, 6:239-244.

Ghazal, S., Al-Samarraie, H. and Aldowah, H., 2018. "I am still learning": Modeling LMS critical success factors for promoting students' experience and satisfaction in a blended learning environment. *IEEE Access*, *6*:77179-77201.IEEE. DOI: 10.1109/ACCESS.2018.2879677

Gibbons, M. ed., 1994. The new production of knowledge: The dynamics of science and research in contemporary societies. Sage.

Gigler, B.S. 2015. Poor People's Information Needs, Perceptions, and Expectations about the Internet. In *Development as Freedom in a Digital Age: Experiences from the Rural Poor in Bolivia*. The World Bank. 115–167. DOI: 10.1596/978-1-4648-0420-5_ch4.

Gillwald, A., Mothobi, O., & Rademan, B. 2018. Policy Paper no 5, series 5. *After Access: The state of ICT in South Africa*. Cape Town. Research ICT Africa

Goodyear, P., Salmon, G., Spector, J.M., Steeples, C. and Tickner, S., 2001. Competences for online teaching: A special report. *Educational Technology Research and Development*. 49(1):65-72.

Government programmes and policies. N.d. Basic Services https://www.etu.org.za/toolbox/docs/government/basic.html#free [2 August 2019]

Gregor, S., Kruse, L.C. & Seidel, S., 2020. The Anatomy of a Design Principle. *Journal of the Association for Information Systems.*

Gubbi, J., Buyya, R., Marusic, S. & Palaniswami, M. 2013. Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions. *Future generation computer systems*. 29(7):1645–1660. Available: www.buyya.com. [2021, June 10].

Guzmán, J.G., del Carpio, A.F., Colomo-Palacios, R. & de Diego, M.V., 2013. Living labs for user-driven innovation: a process reference model. *Research-Technology Management.* 56(3):29-39.

Haggans, M. 2016. The 21st-Century Campus. *Planning for Higher Education Journal*, 44(3):1–8. Available: www.scup.org/phe [2021, June 13].

Haseeb, M., Hussain, H.I., Kot, S., Androniceanu, A. & Jermsittiparsert, K., 2019. Role of social and technological challenges in achieving a sustainable competitive advantage and sustainable business performance. *Sustainability*. *11*(14):3811.

Hatakka, M., Thapa, D. & Sæbø, Ø. 2020. Understanding the role of ICT and study circles in enabling economic opportunities: Lessons learned from an educational project in Kenya. *Information Systems Journal*. 30(4):664–698. DOI: 10.1111/isj.12277.

Heeks, R. 2002. Information Systems and Developing Countries: Failure, Success, and Local Improvisations. *The Information Society*. 18(2):101–112. DOI: 10.1080/01972240290075039.

Herrington, J. & Reeves, T.C., 2011. Using design principles to improve pedagogical practice and promote student engagement.

Hevner, A.R., March, S.T., Park, J. & Ram, S., 2004. Design science in information systems research. *MIS quarterly*.75-105.

Hevner, A. & Chatterjee, S., 2010. Design science research in information systems. In Design research in information systems. 9-22. Springer, Boston, MA.

Hollands, R.G. 2008. Will the real smart city please stand up? *Routledge Companion to Smart Cities*. 12(3):1470–3629. DOI: 10.1080/13604810802479126.

Hughes, A. & Kitson, M., 2012. Pathways to the impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development. *Cambridge Journal of Economics*. 36(3):723-750.

Ifinedo, P. 2005. Measuring Africa's e-readiness in the global networked economy: A nine-country data analysis. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*. 1(1):53–71.

Imgrund, F., Fischer, M., Janiesch, C. & Winkelmann, A., 2018. Approaching digitalization with business process management. *Proceedings of the MKWI*. 1725-1736.

Intelligent Community. n.d Intelligent community indicators https://www.intelligentcommunity.org/intelligent_community_indicators [1 August 2019]

Ismagilova, E., Hughes, L., Dwivedi, Y.K. & Raman, K.R. 2019. Smart cities: Advances in research—An information systems perspective. *International Journal of Information Management*. 47:88–100. DOI: 10.1016/j.ijinfomgt.2019.01.004.

ISO DIS 9241-210:2010. Ergonomics of human system interaction - Part 210: Human-centred design for interactive systems (formerly known as 13407). International Standardization Organization (ISO). Switzerland.

ITU. 2018. Measuring the Information Society. International Telecommunications Union. https://www.itu.int/en/ ITU-D/Statistics/Pages/publications/misr2018.aspx.

Jordaan, C.G., Malekian, N. & Malekian, R., 2019. Internet of things and 5G solutions for development of smart cities and connected systems. *Communications of the CCISA*, 25(2):1-16.

Kariippanon, K.E., Cliff, D.P., Okely, A.D. & Parrish, A.M., 2019. The 'why'and 'how'of flexible learning spaces: A complex adaptive systems analysis. *Journal of Educational Change*.1-25. DOI: 10.1371/journal.pone.0223607.

Kenny, C. 2003. Oxford Development Studies: The Internet and Economic Growth in Less-developed Countries: A Case of Managing Expectations? The Internet and Economic Growth in Less-developed Countries: A Case of Managing Expectations? 1. *Oxford Development Studies*. 31(1):99–113. DOI: 10.1080/1360081032000047212.

Klein, H.K. & Myers, M.D., 2001. A classification scheme for interpretive research in information systems. In Qualitative research in IS: issues and trends. 218-239. IGI Global.

Kolehmainen, J., Irvine, J., Stewart, L., Karacsonyi, Z., Szabó, T., Alarinta, J. & Norberg, A. 2016. Quadruple Helix, Innovation and the Knowledge-Based Development: Lessons from Remote, Rural and Less-Favoured Regions. *Journal of Knowledge Economy*. 7(1):23–42. DOI: 10.1007/s13132-015-0289-9.

Komljenovic, J., 2020. The future of value in digitalised higher education: why data privacy should not be our biggest concern. *Higher Education*. 1-17. DOI: 10.1007%2Fs10734-020-00639-7

Kostoff, R.N., Boylan, R. & Simons, G.R. 2004. Disruptive technology roadmaps . *Technological forecasting and Social Change*. 71(2):141–159. DOI: 10.1016/S0040-1625(03)00048-9.

Kuni, T. 1997. The 3rd industrial revolution through integrated intelligent processing systems. In *IEEE International Conference on Intelligent Processing Systems*. Beijing: IEEE. 1–6. DOI: 10.1109/ICIPS.1997.672730.

Kwok, L.-F. 2015. A vision for the development of i-campus. *Smart Learning Environments*. 2(1):1–12. DOI: 10.1186/s40561-015-0009-8.

Langford, L., 2004. Preventing Violence and Promoting Safety in Higher Education Settings: Overview of a Comprehensive Approach. *Higher Education Center for Alcohol and Other Drug Abuse and Violence Prevention*.

Langset, I.D., Jacobsen, D.Y. and Haugsbakken, H., 2018. Digital professional development: towards a collaborative learning approach for taking higher education into the digitalized age. *Nordic Journal of Digital Literacy*. 13(1):24-39.

Lasi, H., Fettke, P., Kemper, H.G., Feld, T. & Hoffmann, M., 2014. *Industry 4.0. Business & information systems engineering.* 6(4):239-242.

Lee, D.S., 1999. Wage inequality in the United States during the 1980s: Rising dispersion or falling minimum wage? *The Quarterly Journal of Economics.* 114(3):977-1023.

Lee, J., Bagheri, B. & Kao, H.A., 2014, July. Recent advances and trends of cyber-physical systems and big data analytics in industrial informatics. *In International proceeding of int conference on industrial informatics (INDIN).*1-6

Lee, I. & Lee, K. 2015. The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons*. 58(4):431–440. DOI: 10.1016/j.bushor.2015.03.008.

Leigland, J., 1994. Public authorities and the determinants of their use by state and local governments. *Journal of Public Administration Research and Theory*. 4(4):521-544.

Letaifa, S.B., 2015. How to strategize smart cities: Revealing the SMART model. *Journal of Business Research.* 68(7):1414-1419.

Leydesdorff, L. 2012. The Triple Helix, Quadruple Helix, ..., and an N-Tuple of Helices: Explanatory Models for Analyzing the Knowledge-Based Economy? *Journal of the Knowledge Economy*. 3(1):25–35. DOI: 10.1007/s13132-011-0049-4.

Lienig, J. & Bruemmer, H., 2017. Fundamentals of electronic systems design. Springer.

Lindskog, H. 2004. Smart communities initiatives. In *In Proceedings of the 3rd ISOneWorld Conference.* 14–16. Available: http://heldag.com/articles/Smart%20communities%20april%202004.pdf [2021, June 08].

Lucas, H. 2008. Information and communications technology for future health systems in developing countries. *Social Science and Medicine*. 66(10):2122–2132. DOI: 10.1016/j.socscimed.2008.01.033.

Majeed, M.· & Khan, N. 2019. Do information and communication technologies (ICTs) contribute to health outcomes? An empirical analysis. *Quality & Quantity*. 53(1):183–206. DOI: 10.1007/s11135-018-0741-6.

Malatji, E.M. 2017. The Development of a Smart Campus-African Universities Point of View. In *2017 8th International Renewable Energy Congress.* IEEE. 1–5.

Manda, M.I. & Ben Dhaou, S., 2019, April. Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. In *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance*. 244-253

Martin, R.L. & Osberg, S., 2007. Social entrepreneurship: The case for definition.

Mattes, R.B., 2002. South Africa: democracy without the people? *Journal of Democracy*. 13(1):22-36.

Mattoni, B., Bisegna, F., Gugliermetti, F., Mattoni, B., Pagliaro, F., Corona, G., Ponzo, V., Gugliermetti, F., et al. 2016. A matrix approach to identify and choose efficient strategies to develop the Smart Campus. In *2016 IEEE International Conference on Environment and Electrical Engineering*. IEEE. 1–6. DOI: 10.1109/EEEIC.2016.7555571.

Mell, P. & Grance, T. 2011. *The NIST Definition of Cloud Computing Recommendations of the National Institute of Standards and Technology*. Gaithersburg.

Merkofer, P. & Murphy, A., 2009. The e-skills landscape in South Africa. *Zeitschrift für Politikberatung.* 2(4):685-695.

Miller, K., McAdam, R. and McAdam, M., 2018. A systematic literature review of university technology transfer from a quadruple helix perspective: toward a research agenda. *R&D Management.* 48(1):7-24.

Min-Allah, N. & Alrashed, S. 2020. Smart campus—A sketch. *Sustainable Cities and Society*. 59:102231. DOI: 10.1016/j.scs.2020.102231.

MIT innovation initiative. n.d. *Resources* https://innovation.mit.edu/resources/ [14 June 2019].

Mkansi, M. & Landman, N., 2021. The future of work in Africa in the era of 4IR–The South African perspective. *Africa Journal of Management,* 1-14. DOI: 10.1080/23322373.2021.1930750.

Mouton, J., 2001. How to succeed in your master's and doctoral studies: A South African guide and resource book. Van Schaik.

Muhamad, W., Kurniawan, N.B., Suhardi, S. & Yazid, S. 2017. Smart campus features, technologies, and applications: A systematic literature review Service Computing System View project

complex service computing for digital service industries View project. In *2017 International Conference on Information Technology Systems and Innovation*. IEEE. 384–391. DOI: 10.1109/ICITSI.2017.8267975.

Müller, C., Stahl, M., Alder, M. & Müller, M. 2018. Learning Effectiveness and Students' Perceptions in a Flexible Learning Course. *European Journal of Open, Distance and E-Learning*. 21(2):44–52. Available: www.zhaw.ch], [2021, June 14].

Mutula, S.M. 2005. Peculiarities of the digital divide in sub-Saharan Africa. *Program: Electronic library and Information Systems*. 39(2):122–138. DOI: 10.1108/00330330510595706.

Murray, J., 2018. Student-led action for sustainability in higher education: A literature review. *International Journal of Sustainability in Higher Education*. DOI: 10.1108/IJSHE-09-2017-0164/full/html

Naidoo, P. & Cartwright, D., 2020. Where to from Here? Contemplating the Impact of COVID-19 on South African Students and Student Counselling Services in Higher Education. *Journal of College Student Psychotherapy*. 1-15. DOI: doi.org/10.1080/87568225.2020.1842279

Naidu, S. 2017. Openness and flexibility are the norm, but what are the challenges? *Distance Education*. 38(1):1–4. DOI: 10.1080/01587919.2017.1297185.

Ndou, V. 2004. E-Government for developing countries: Opportunities and challenges. *The Electronic Journal on Information Systems in Developing Countries*. 18(1):1–24. Available: http://www.ejisdc.org [2021, June 13].

Nordberg, K., Mariussen, Å. and Virkkala, S., 2020. Community-driven social innovation and quadruple helix coordination in rural development. Case study on LEADER group Aktion Österbotten. *Journal of Rural Studies*, 79:157-168. DOI: doi.org/10.1016/j.jrurstud.2020.08.001

OECD. 2017. Getting Skills Right: South Africa, Getting Skills Right, OECD Publishing, Paris, https://doi.org/10.1787/9789264278745-en.

Olaitan, O., Issah, M. & Wayi, N., 2021. A framework to test South Africa's readiness for the fourth industrial revolution. *South African Journal of Information Management*. 23(1):10. DOI: 10.4102/sajim.v23i1.1284

Pagliaro, F., Mattoni, B., Gugliermenti, F., Bisegna, F., Azzaro, B., Tomei, F. & Catucci, S. 2016. A roadmap toward the development of Sapienza Smart Campus. In *EEEIC 2016 - International Conference on Environment and Electrical Engineering*. Institute of Electrical and Electronics Engineers Inc. 1–6. DOI: 10.1109/EEEIC.2016.7555573.

Parveen, S., Senin, A.A. & Umar, A., 2015. Organization culture and open innovation: A quadruple helix open innovation model approach. *International Journal of Economics and Financial Issues*. 5(1):335-342.

Pascal, A. & Renaud, A., 2020, January. 15 Years of Information System Design Science Research: A Bibliographic Analysis. In Proceedings of the 53rd Hawaii International Conference on System Sciences.

Peffers, K., Tuunanen, T., Rothenberger, M.A. & Chatterjee, S., 2007. A design science research methodology for information systems research. Journal of management information systems. 24(3):45-77.

Pereira, G., Parycek, P., Falco, E. & Kleinhans, R. 2018. Smart Governance in the Context of Smart Cities: A Literature Review. *Information Polity*. 23(2):143–162. DOI: 10.3233/IP-170067.

Perkmann, M. & Walsh, K., 2007. University–industry relationships and open innovation: Towards a research agenda. *International journal of management reviews*. 9(4):259-280.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A. & Krabel, S., 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. Research policy, 42(2):423-442.

Pierson, J. & Lievens, B., 2005, November. Configuring living labs for a 'thick'understanding of innovation. In *Ethnographic Praxis in Industry Conference Proceedings*. 1:114-127. Oxford, UK: Blackwell Publishing Ltd.

Pownall, M., Harris, R. & Blundell-Birtill, P., 2021. Supporting students during the transition to university.

Reidenberg, J.R. & Schaub, F., 2018. Achieving big data privacy in education. *Theory and Research in Education*, *16*(3):263-279. DOI:/10.1177/1477878518805308.

Reja, U., Manfreda, K.L., Hlebec, V. & Vehovar, V., 2003. Open-ended vs. close-ended questions in web questionnaires. *Developments in applied statistics.* 19(1):159-177.

Roztocki, N., Soja, P. & Weistroffer, H.R. 2019. Information Technology for Development The role of information and communication technologies in socioeconomic development: towards a multi-dimensional framework. *Taylor and Francis*. 25(2):171–183. DOI: 10.1080/02681102.2019.1596654.

Russell, M.G. & Smorodinskaya, N. v. 2018. Leveraging complexity for ecosystemic innovation. *Technological Forecasting and Social Change*. 136:114–131. DOI: 10.1016/j.techfore.2017.11.024.

Sahay, S. & Avgerou, C. 2002. Introducing the Special Issue on Information and Communication Technologies in Developing Countries. *The Information Society*. 18(2):73–76. DOI: 10.1080/01972240290075002.

Salter, A.J. & Martin, B.R., 2001. The economic benefits of publicly funded basic research: a critical review. *Research policy*. 30(3):509-532.

Sanders, E.B.N. & Stappers, P.J., 2008. Co-creation and the new landscapes of design. Co-design, 4(1):5-18.

Saunders, M., Lewis, P & Thornhill, A., 2007. *Research Methods for Business Students.* 4th ed. England: Pearson Education Limited.

Saunders, M., Lewis, P & Thornhill, A., 2019. *Research Methods for Business Students.* 8th ed. England: Pearson Education Limited.

Schaffers, H., Cordoba, M.G., Hongisto, P., Kallai, T., Merz, C. & Van Rensburg, J., 2007, June. Exploring business models for open innovation in rural living labs. *In Technology Management Conference (ICE),* 2007 IEEE International. 1-8.

Schuler, D., 2001, October. Digital cities and digital citizens. *In Kyoto Workshop on Digital Cities.*71-85. Springer, Berlin, Heidelberg.

Schuler, D. 2002. Digital cities and digital citizens. In *Lectures in Kyoto workshop on Digital Cities*. V. 2362. Berlin: Springer Verlag. 71–85. DOI: 10.1007/3-540-45636-8_6.

Schumacher, J. & Feurstein, K., 2007, June. Living Labs-the user as co-creator. *In Technology Management Conference (ICE), 2007 IEEE International.*1-6. IEEE.

Schuurman, D., Lievens, B., De Marez, L. & Ballon, P., 2012. Innovation from user experience in living labs: revisiting the 'innovation factory'-concept with a panel-based and user-centered approach. In Conference: Action for Innovation: Innovating from Experience (ISPIM XXIII-2012). Ghent University, Department of Communication studies.

Schuurman, D., De Marez, L. & Ballon, P., 2015. Living Labs: a systematic literature review. In Open Living Lab Days 2015.

Schuurman, D., De Marez, L. & Ballon, P., 2016. The impact of living lab methodology on open innovation contributions and outcomes. Technology Innovation Management Review, 6(1).

Schuurman, D. 2015. Bridging the gap between Open and User Innovation? exploring the value of Living Labs as a means to structure user contribution and manage distributed innovation. Available: https://biblio.ugent.be/publication/5931264/file/5931265.pdf [2021, Ju Statistics South Africa. 2019. Discouragement decreases and unemployment increases in the second quarter of 2019 http://www.statssa.gov.za/?p=12376 [12 August 2019]

Schuster, R., Wagner, G. and Schryen, G., 2018. Information Systems Design Science Research and Cumulative Knowledge Development: An Exploratory Study.

Scuotto, V., Ferraris, A. & Bresciani, S., 2016. Internet of Things: Applications and challenges in smart cities: a case study of IBM smart city projects. *Business Process Management Journal.* 22(2):357-367.

Silva, B.N., Khan, M. & Han, K., 2018. Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society.* 38:697-713. DOI: 10.1016/j.scs.2018.01.053.

Silver, M.S., Markus, M.L. & Beath, C.M., 1995. The information technology interaction model: A foundation for the MBA core course. *MIS quarterly.* 361-390.

South Africa. Department of Economic Development and Tourism. 2018. *Western Cape Digital Skills Shared Agenda for Action.* Available at: https://www.westerncape.gov.za/assets/skills_boost_western_cape_-_as_is_-_final_report.pdf [Accessed: 10 August 2019].

South Africa. National Media Institute of South Africa. 2019. *Nemisa Annual Report*. Johannesburg: Government Printer.

South Africa. Statistics South Africa. 2019. *Quarterly Labour Force Survey.* Pretoria: Government printer 13.

Ssekakubo, G., Suleman, H. & Marsden, G. 2011. Issues of Adoption: Have E-Learning Management Systems Fulfilled their Potential in Developing Countries? In *In Proceedings of the South African: Institute of Computer Scientists and Information Technologists conference on knowledge, innovation and leadership in a diverse, multidisciplinary environment.* Cape Town. 231–238. Available: http://labnol.blogspot.com/2006/06/how-to-record-skype- [2021, June 13].

Sutjarittham, T., Gharakheili, H.H., Kanhere, S.S. & Sivaraman, V. 2018. Realizing a Smart University Campus: Vision, Architecture, and Implementation. In *2018 IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)*. IEEE. 1–6.

Taherdoost, H., 2016. Validity and reliability of the research instrument; how to test the validation of a questionnaire/survey in a research. *How to test the validation of a questionnaire/survey in a research (August 10, 2016)*.

Terre Blanche, M. & Durrheim, K., 1999. Histories of the present: Social science research in context. *Research in practice: Applied methods for the social sciences*. 2:1-17.

Thornhill, A., Saunders, M. & Lewis, P., 2009. Research methods for business students. London: Pearson Education.

Tranos, E. & Gertner, D. 2012. Smart networked cities? *Innovation: The European Journal of Social Science Research*. 25(2):175–190. DOI: 10.1080/13511610.2012.660327.

Tryfonas, T. & Crick, T. 2018. Public Policy and Skills for Smart Cities: The UK Outlook * CCS Concepts • Social and professional topics. In *In Proceedings of the 11th Pervasive Technologies Related to Assistive Environments Conference*. 116–117. DOI: 10.1145/3197768.3203170.

UN (United Nations). 2014. World Urbanization Prospects: The 2014 Revision. New York: United Nations.

University of the Western Cape. 2013. Available: https://www.uwc.ac.za/Pages/default.aspx [27 April 2018].

Van Audenhove, L., Marien, I., Craffert, L. & Grove, W. 2018. South Africa's e-Skills Policy. From e-Skills to Media Literacy? In *IST-Africa 2018 Conference Proceedings*. P. Cunningham & M. Cunningham, Eds. IEEE. 978–979. Available: www.IST-Africa.org/Conference2018 [2021, June 13].

Van den Berg, L. & Raubenheimer, J., 2015. Food insecurity among students at the University of the Free State, South Africa. *South African Journal of Clinical Nutrition*, *28*(4):160-169. DOI: 10.10520/EJC182622.

Van Deursen, A. & Van Dijk, J., 2011. Internet skills and the digital divide. New media & society, 13(6):893-911.

Van Deursen, A.J.A.M. & Van Diepen, S., 2013. Information and strategic Internet skills of secondary students: A performance test. Computers & Education, 63:218-226.

Van Deursen, A.J., van Dijk, J.A. & Peters, O., 2011. Rethinking Internet skills: The contribution of gender, age, education, Internet experience, and hours online to medium-and content-related Internet skills. *Poetics.* 39(2):125-144.

Van Deursen, A. & van Dijk, J. 2011. Internet skills and the digital divide. *New Media and Society*. 13(6):893–911. DOI: 10.1177/1461444810386774.

Van Dijk, J.A., 2005. The deepening divide: Inequality in the information society. *Sage Publications.*

Van Dijk, J.A., 2006. Digital divide research, achievements and shortcomings. *Poetics.* 34(4-5): 221-235.

Van Dijk, J.A. & Van Deursen, A.J., 2014. Digital skills: Unlocking the information society. Palgrave Macmillan.

Van Laar, E., van Deursen, A.J.A.M., van Dijk & de Haan, J. 2017. The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*. 72:577–588. DOI: 10.1016/j.chb.2017.03.010.

Van Laar, E., Van Deursen, A.J., Van Dijk, J.A. & De Haan, J., 2019. The sequential and conditional nature of 21st-century digital skills. *International Journal of Communication*, 13:26.

Venkatesh, V., Brown, S.A. & Bala, H., 2013. Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS quarterly.* 21-54.

Villegas-Ch, W., Palacios-Pacheco, X. & Luján-Mora, S. 2019. Application of a smart city model to a traditional university campus with a big data architecture: A sustainable smart campus. *Sustainability*. 11(10):2857-undefined. DOI: 10.3390/su11102857.

Von Richthofen, A., Tomarchio, L. & Costa, A., 2019. Identifying Communities within the Smart-Cultural City of Singapore: A Network Analysis Approach. *Smart Cities*. 2(1):66-81. DOI: 10.3390/smartcities2010005.

Voytenko, Y., McCormick, K., Evans, J. & Schliwa, G., 2016. Urban living labs for sustainability and low carbon cities in Europe: Towards a research agenda. *Journal of Cleaner Production.* 123:45-54.

Wade, R.H. 2002. Bridging the Digital Divide: New Route to Development or New Form of Dependency. *Global Governance*. 8(4):443–466. Available: https://heinonline.org/HOL/Page?handle=hein.journals/glogo8&id=453&div=39&collection=journals [2021, June 13].

Wang, F. & Hannafin, M.J., 2005. Design-based research and technology-enhanced learning environments. Educational technology research and development, 53(4):5-23.

Warschauer, M. 2003. The Information Society Dissecting the "Digital Divide": A Case Study in Egypt. *The Information Society*. 19(4):297–304. DOI: 10.1080/01972240309490.

West, D.M., 2015. Digital divide: Improving Internet access in the developing world through affordable services and diverse content. Brookings Institution.

West, J., Vanhaverbeke, W. & Chesbrough, H., 2006. Open innovation: a research agenda. Open innovation: Researching a new paradigm. 285-307.

West, J., Salter, A., Vanhaverbeke, W. & Chesbrough, H., 2014. Open innovation: The next decade.

World Economic Forum. *Readiness for Future of Production. 2018.* Available at: http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf [Accessed: 20 August 2019]

Yun, J.J. and Liu, Z., 2019. Micro-and macro-dynamics of open innovation with a quadruple-helix model.

Yusuf, M., Alamsyah, N., Syarif, Muh., Muntasa, A. & Muzakki, H. 2019. A novel framework of e-participation for smart cities. *Bulletin of Social Informatics Theory and Application*. 3(2):45–55. DOI: 10.31763/businta.v3i2.213.

Zanjani, N., 2017. The important elements of LMS design that affect user engagement with e-learning tools within LMSs in the higher education sector. *Australasian Journal of Educational Technology, 33*(1):19-31. AJET.

Zhang, K., Suo, J., Chen, J., Liu, X. & Gao, L., 2017. Design and implementation of fire safety education system on campus based on virtual reality technology. In *2017 Federated Conference on Computer Science and Information Systems (FedCSIS)* IEEE.1297-1300.

Zohrabi, M., 2013. Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings. *Theory & practice in language studies*, *3*(2).

Zvieriakov, M. & Zavadska, D. 2018. Model of Intensive Innovative Development: World Experience of Implementation and Trends of Formation in Ukraine. *Scientific Bulletin of National Mining University*. 155–166. Available: https://web.b.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=20712227&AN=132933274&h=uVlXLx19V2qalqVaOwInyp2NvtzKIH32n59C8oVJRED8%2fqL%2b%2fVnvQln%2buB2JlAEdjv1j3z%2biqzXzmj1Qp5PR4w%3d%3d&crl=c&resultNs=AdminWebAuth&resultLocal=ErrCrlNotAuth&crlhashurl=login.aspx%3fdirect%3dtrue%26profile%3dehost%26scope%3dsite%26authtype%3dcrawler%26jrnl%3d20712227%26AN%3d132933274 [2021, June 13].

Appendix A: Ethical clearance documentation

UNIVERSITY *of the*
WESTERN CAPE

02 July 2020

Ms I Kariem
Information Systems
Faculty of Economics and Management Sciences

Ethics Reference Number: HS 20/4/47

Project Title: Co-designing a stakeholder responsibility framework for digital skills development within higher education communities in South Africa

Approval Period: 01 July 2020 – 01 July 2023

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer

Appendix B: Information sheet sent to the participants

ONLINE SURVEY INFORMATION SHEET

University of the Western Cape

Faculty of Economic and Management Sciences

Department of Information Systems

Research Project Information Sheet: Online Survey

Project Title:	**A digital skills development framework for digitally maturing South African Higher Education Institutions**

What is this study about?

My name is Ilse Kariem, a student at the University of the Western Cape (South Africa) pursuing a master's degree in Information Systems. My study is about the journey of South African Higher Education (HE) campuses as they move from being traditional, predominantly offline campuses towards being digitally inclusive campuses using 4IR or "smart", technologies optimally to enhance HE. Campuses can be seen as micro-communities that lend themselves well to the study of the transition from the traditional to the new, and we foresee that researching this transition journey of a South African campus – the challenges, the skills requirements, and the responsibilities involved - may provide insights into similar transition journeys of other (non HE) communities.

The objective of the study is to determine the challenges faced by Higher Education campuses in South Africa as they transition from traditional campuses to digital campuses using "smart technologies", the skills required on this journey, and the responsibilities of different stakeholder groups to solve these smart campus related challenges. The digital skills required to participate fully in the functioning of a "smart" campus, overcoming the mentioned challenges, serves as a point of departure for the investigation.

I am conducting an online survey to help me in my investigation. The purpose of the online survey is to allow you as a participant to express your personal point of view with regards to a set of challenges that campuses face when using new smart technologies on campus, and to share your views about what responsibilities within each stakeholder group (the university, academia, the public sector, and the private sector) has to supply the digital skills to citizens (students) of digital campuses. An online survey via Google forms to provide the necessary fundamental questions to you as a student.

This study is solely for academic purposes.

What will I be asked to do if I agree to participate?

If you agree to participate in this research project, you will be asked to respond to a number of structured, open-ended and closed-ended questions as part of the online survey. If you choose to accept you will be asked to complete an online survey. The duration of the online survey will be 20 to 30 minutes. If the participant feels any adverse feelings towards a question, he/she does not have to answer the question.

Would my participation in this study be kept confidential?

Confidentiality and anonymity are of utmost importance. Personal information related to your identity will not be noted or distributed in the study. Thus, information related to your gender, age, and area of expertise will remain anonymous. The researcher involved in the current study is strictly obliged to adhere to the rules and ethics of applied research and are prohibited from divulging personal information collected in the course of their professional activities. Breach of these rules can lead to sanctions for the researcher involved.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. Confidentiality will be maintained in the research reporting by means of referring to the online survey as participants by assignment of a unique number. The online survey responses will be summarised into codes, themes, and categories. This will be used as a basis of reporting on the research in the thesis and in and associated research article, not the names of participants. The researcher further pledges that any information given by the participants will be handled in the strictest confidence, and that the information participants give will not be used to reflect negatively on them in any way.

What are the risks of this research?

No potential risks are envisaged at this stage. However, if something might come up, it will be dealt with in a sensible and sensitive manner.

What are the benefits of this research?

The study proposes to design a framework that can be used by HE campuses to address the challenges of becoming a "smart" campus, by determining the digital skills needed to solve each of the identified challenges, and stipulating the responsibilities of each stakeholder group to solve the challenges.

The findings and conclusions of this research will be available in a summary format, which you may request from the researcher.

Do I have to be in this research, and may I stop participating at any time?

Your participation in the online survey is entirely voluntary. You are welcome to refrain from taking part in the study. You may withdraw your consent at any time and discontinue participation without penalty, for any reason whatsoever, including unforeseen adverse feelings encountered during the research process. You are not waiving any legal claims, rights, or remedies because of your participation in this research study.

What if I have questions?

If you have any questions, feel free to contact the study leader:

Contact details of project leader (study supervisor)

Name: Dr Johan Breytenbach

University of the Western Cape, Department of Information Systems
Telephone: 021 959 2911
Email: jbreytenbach@uwc.ac.za

Contact details of student

Name: Ilse Kariem
Telephone: 081 365 3377
Email: 3222070@myuwc.ac.za

NOTE: *This research project has received ethical approval from the Humanities & Social Sciences Research Ethics Committee of the University of the Western Cape, Tel. 021 959 2988, email: research-ethics@uwc.ac.za*

Appendix C: Consent form sent to participants

University of the Western Cape

Faculty of Economic and Management Sciences

Department of Information Systems

Research Participant Consent Form: Online Survey

Project Title:	**A digital skills development framework for digitally maturing South African Higher Education Institutions**

Please tick Yes or No to each of the following

	Yes	No
1. I confirm that I have read and understand the information sheet explaining the above research project and I have had the opportunity to ask questions about the project.		
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences.		
3. I understand that should I not wish to answer any particular question or questions, I am free to decline.		
4. I understand my responses and personal data will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the reports or publications that result for the research.		
5. I agree for the data collected from me to be used in future research.		
6. I agree to take part in the above research project.		

_____	_____	_____
Name of Participant (*or legal representative*)	Date	Signature
_____	_____	_____
Name of person taking consent	Date	Signature

Contact details of study supervisor:

Name: Dr Johan Breytenbach

University of the Western Cape

Department of Information Systems

Telephone: 021 959 2911

Email: jbreytenbach@uwc.ac.za

Appendix D: Survey Questions: Google Forms

Master's study survey

Thank you for taking the time out of your day to participate in my study. Research suggests, that as traditional universities move towards becoming smart campus communities, an university will invariably face certain digital and non-digital challenges. The researcher has divided this journey into four phases namely, (1) foundational challenges, (2) core services provided by the university, (3) integration of services and (4) sustainability of digital initiatives as it relates to growth and wealth creation. My study suggests that these challenges can be solved by the culmination of Internet and Communications Technology (ICT) innovations and more importantly the digital upskilling of campus community members. The purpose of my study is to determine the digital skills needed to function optimally in a smart campus environment. If you agree to proceed with the survey, please note that your information will remain confidential. Note that if you have any adverse feelings towards a certain question you may refrain from answering the question. Kindly answer as honestly as possible. Do not hesitate to contact me on @ 3222070@myuwc.ac.za, should you have any queries.

Participant background information

The following section concerns personal details of each participant. Please note that this information will remain anonymous and will only be used for the purpose of this study.

Are you currently a student at UWC (University of the Western Cape)? *

- Yes
- No

If yes, what are you currently studying? (eg. Bcom Law)

Short answer text

What is your current age? *

- Younger than 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 and older

What is your gender? *

- Male
- Female

What is your ethnicity? *

- African
- White
- Coloured
- Indian
- Other
- Other...

What degree/diploma are you currently pursuing? *

- National Senior Certificate
- Diploma/Undergraduate degree
- Honour's degree
- Master's degree
- Doctorate degree
- Other
- Other...

Foundational Challenges

The following section pertains the various foundational challenges universities face when transitioning from a traditional higher education community to a smart campus community. In order to transition certain key components need to be in place. These components are, network/internet availability, access to data and digital devices (on/off-campus) and efficient mobility of students both on and off campus. Please answer the questions below.

The image blow illustrates the journey of a traditional campus moving towards becoming a smart campus community.

Do you have access to internet connectivity at your residential address? *

- ○ Yes
- ○ No

Please select the digital devices you have access to. *

- ☐ Tablet
- ☐ Smartphone
- ☐ Laptop
- ☐ Notebook
- ☐ Desktop computer
- ☐ None of the above
- ☐ Other...

How would you rate your current basic digital literacy skills?

	Expert leve...	Highly skill...	Very skilled	Somewhat...	Not very s...	Not skilled...	No knowle...
1. Problem...	☐	☐	☐	☐	☐	☐	☐
2. Transact...	☐	☐	☐	☐	☐	☐	☐
3. Handlin...	☐	☐	☐	☐	☐	☐	☐
4. Commu...	☐	☐	☐	☐	☐	☐	☐
5. Content ...	☐	☐	☐	☐	☐	☐	☐
6. Personal...	☐	☐	☐	☐	☐	☐	☐

How would you rate your user skills?

	Expert leve...	Highly skill...	Very skilled	Somewhat...	Not very s...	Not skilled...	No knowle...
1. Word pr...	☐	☐	☐	☐	☐	☐	☐
2. Spreads...	☐	☐	☐	☐	☐	☐	☐
3. Web sur...	☐	☐	☐	☐	☐	☐	☐
4. Collabor...	☐	☐	☐	☐	☐	☐	☐
5. Privacy -...	☐	☐	☐	☐	☐	☐	☐
6. Security ...	☐	☐	☐	☐	☐	☐	☐
7. Social M...	☐	☐	☐	☐	☐	☐	☐
8. Cloud se...	☐	☐	☐	☐	☐	☐	☐
9. Ethical o...	☐	☐	☐	☐	☐	☐	☐

Have you received any basic digital skills training at UWC? For example: Transacting online, creating content (spreadsheet, text, slides), using mobile applications.

- ○ Yes
- ○ No
- ○ I have received some training

What basic digital skills training have you received at UWC?

Long answer text

Have you received any user skills training at UWC? For example: Microsoft Word/Excel, web surfing, online communication (Zoom), online privacy and security training?

- ◯ Yes
- ◯ No
- ◯ I have received some training

What user skills training have you received at UWC?

Long answer text

Do you primarily stay on/off campus? (Before Covid-19 pandemic) *

- ◯ At campus residence 'on - campus'
- ◯ At campus residence 'off - campus'
- ◯ Off-campus

Challenge 1 : On site mobility

Flexibility in terms of mobility on campus is a key concern smart universities face. On campus mobility refers to the ability of university management to ensure that physical activity is more efficient to improve the productivity of community members. (Eg: Parking). Mobility in terms of locating nearest route to classes, finding parking and locating the nearest food services remains a challenge within traditional campus environments. The following question related to on campus mobility challenges.

Do you agree that this is in fact a challenge students experience?

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you think optimization of on - campus digital services might benefit you and your peers? (For example: implementing a parking assistance app)

- ◯ Yes
- ◯ No
- ◯ I do not know

If you stay far from campus, do you think you and your peers might benefit from an optimized system to either locate parking/find nearest routes to classes on campus?

- ◯ Yes
- ◯ No
- ◯ I do not know

What digital skills would you need to be a confident user of the system mentioned above?

Long answer text

Core Services Challenges

Once a university implemented all the elements needed within the foundational phase (access to devices, internet, basic skills induction, etc.), it can determine how to improve their primary services on campus. The core services describe the services rendered within a higher education community. These services ensure that student needs are met. The services include: administration of student affairs, teaching and learning (academic) departments, safety processes and regulations, privacy policies to protect students personal data. Challenges concerning the core services of an university are highlighted below. Please answer accordingly.

Challenge 2 : Physical safety

Physical safety is critical within the borders of a campus community in order for students and staff to learn and teach successfully. Students and staff need to feel safe in the environment in which the study and work. The following questions concerns your physical safety as a student on campus.

Have you ever felt unsafe walking or driving alone on campus?

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you think that physical safety on campus is a challenge students experience?

- ◯ Yes
- ◯ No
- ◯ I do not know

What assistance would have helped you to feel safer on campus?

Long answer text

Do you think we could use technological advancements to solve this challenge? (For example: a campus safety app)

- ◯ Yes
- ◯ No
- ◯ I do not know

What digital skills would you require to use the safety application?

Long answer text

Challenge 3: Data privacy

Privacy in terms of personal protection of your data is of critical importance in a campus community. Many threats exists to compromise and steal certain personal information. The following questions on privacy issues relate to your personal data.

Are you ever concerned using your personal data online? For example: Using your ID number to access your student email account.

- ◯ Yes
- ◯ No
- ◯ I don't know

Do you think the use of personal data on online platforms is a challenge students experience?

- ◯ Yes
- ◯ No
- ◯ I do not know

What would make you feel at ease when using your personal data online?

Long answer text

Do you think we could use technological advancements to solve this challenge? For example: Making use of a Virtual Private Network (VPN) to safeguard personal information.

- ◯ Yes
- ◯ No
- ◯ I do not know

What digital skills would you need to confidently use the technology mentioned above?

Long answer text

Challenge 4: Student administration

As a result of the pandemic many of the services UWC offers has been moved online. Some of these activities include, online classes, registration and electronic payments. However, students may still have challenges using these services or lack thereof. The following section concerns the difficulty students experience completing administrative tasks online.

Do you find it challenging to complete administrative tasks via online services? Trouble changing modules online/trouble receiving programme advice online/making payments.

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you think that this is in fact a challenge students experience?

- ◯ Yes
- ◯ No
- ◯ I do not know

What would have helped you to complete administrative tasks online?

Long answer text

Do you think we could use technological advancements to solve this challenge?

- ◯ Yes
- ◯ No
- ◯ I do not know

What digital skills would you require to deal with your personal online administrative tasks?

Long answer text

Challenge 5: Class attendance (E-Learning and Physical)

E-learning can be defined as an online platform where educational tools, material and resources are shared between students and lecturers. Evidently, universities across the world are experience an increased demand for educational services. However, some university programmes do not allow for flexibility in terms of attendance. University rules require of a student to be present and accounted for during online and in person classes. Please answer the following questions related to attendance within online and in-person classes.

Have you ever struggled to attend face-to-face classes, or online classes?

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you agree that this is in fact a challenge students experience on campus or online?

- ◯ Yes
- ◯ No
- ◯ I do not know

What assistance would have helped you to improve your class attendance?

Long answer text

Do you think this challenge can be solved by the use of technological advancements?

- ◯ Yes
- ◯ No
- ◯ I do not know

What digital skills would you as a student require to engage confidently on an e-learning platform?

Long answer text

Challenge 6: iKamva

iKamva is a Learning Management System (LMS) used by UWC staff and students to facilitate majority of online activity as related to course material. Students receive course resources from the lecturers, participate in forums and submit assignments. Navigation of this platform is a challenge for community members. All students are not equipped with the digital skills to navigate iKamva.

Have you ever struggled to use iKamva?

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you agree that this is in fact a challenge students experience?

- ◯ Yes
- ◯ No
- ◯ I do not know

If yes, what are the challenges you and your peers experience on iKamva?

Long answer text

Do you think this challenge can be solved by means of technological solutions?

- ◯ Yes
- ◯ No
- ◯ I do not know

If UWC were to update iKamva to suit your needs as a student, what digital skills would you require to be a confident user of this platform?

Long answer text

Integration Challenges

Once the core services of a campus community have been improved (sufficiently digitized), it is then important to asses the state of further areas of the university and how to integrate these areas into the digital lives of students and staff. The areas of concern within the integration phase are, quality of life as it pertains to students' unique experience at university, access to health and wellness services and, availability of quality food products and services. Please answer the questions below as it related to the challenges within the integration phase.

Challenge 7: Campus study areas

The purposive use of ICT presents an opportunity for universities to enhance their learner's performance, learning capabilities and social interactions. Study areas are crucial to the productivity of students on campus. The majority of students make use of campus areas to study, work in teams, and tend to their individual assignments. Innovative study areas have the possibility to improve the learners motivation and quality of life on campus.

Do you think UWC lacks innovative/creative study areas?

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you think that this is in fact a challenge students experience on-campus?

- ◯ Yes
- ◯ No
- ◯ I do not know

What would you have wanted innovative/creative study areas to include? For example: Interactive white boards (other technologies?...)

Long answer text

Do you think we could use technological advancements to solve this challenge?

- ◯ Yes
- ◯ No
- ◯ I do not know

What digital skills would you need to use the technological advancements in the innovative study areas?

Long answer text

Challenge 8: Health and wellness

COVID-19 has presented many challenges in the campus communities across all South African campuses. The health and wellness of employees and of students have taken front stage in ensuring that the campus community remains safe from immediate health threats. The following section concerns the health and wellness concerns of UWC students post pandemic.

In terms of your health and wellness, do you have any concerns returning to campus post - pandemic?

- ◯ Yes
- ◯ No
- ◯ I do not know

Do you think that this is in fact a challenge some students experience?

- ◯ Yes
- ◯ No
- ◯ I do not know

In terms of your health and wellness, what procedures/processes/technology would make you feel comfortable to return to campus?

Long answer text

Do you think we could use technological advancements to solve this challenge? For example: An application to monitor the spread of the virus on campus.

- Yes
- No
- I do not know

What digital skills would you need to confidently use the app required to monitor the spread of the virus?

Long answer text

Challenge 9: Food security

Food security is a key aspect of any smart campus community. Food shortages and scarcity is a grave issue in our underprivileged communities in South Africa. It is critical to assess the research conducted concerning the availability of food on campus to ensure that daily needs of students and staff are met, and that sustainability of food supply and production is achieved. The following question concerns food scarcity in a campus environment.

Have you ever experienced any challenges related to food on campus? For example: Restaurants closing due to the pandemic/ lack of nutritional food on campus/food scarcity

- Yes
- No
- I do not know

Do you think that this is in fact a challenge students experience on campus?

- Yes
- No

Do you think that this is in fact a challenge students experience on campus?

- Yes
- No
- I do not know

What would have helped you to find the various food services on campus?

Long answer text

Do you think this challenge can be solved using technological advancements? For example: Community garden powered by solar power and smart gardening equipment/ an app to show restaurant location, price lists and availability.

- Yes
- No
- I do not know

What digital skill would you require to confidently use smart gardening equipment or food security apps?

Long answer text

Transformation Challenges

The final step within the innovation process is the transformation phase. In this phase the foundational, core services, and integration services have been optimized and streamlined on campus using technology. However, it is important to note that this is an iterative process that requires those involved to always re-assess, re-test and monitor, and change processes within the previous phases if they are deemed outdated or irrelevant. The transformation section ensures that sustainable goals are met and that community members always look to establish growth within the community. Please answer the questions related to transformation challenges.

Challenge 10: Advanced Technologies on Campus

With most of the technological advancements discussed above in place, it becomes possible for a campus to implement new, 4th Industrial Revolution technologies, such as sensors, cameras for detecting movement, and automated support services like robots and chatbots. The following questions relate to the use of these advanced technologies in a campus environment.

Would you accept facial recognition systems to monitor movement and class attendance on campus?

- ◯ Yes
- ◯ No
- ◯ I do not know

Please elaborate as to why you would/would not accept facial recognition systems on campus.

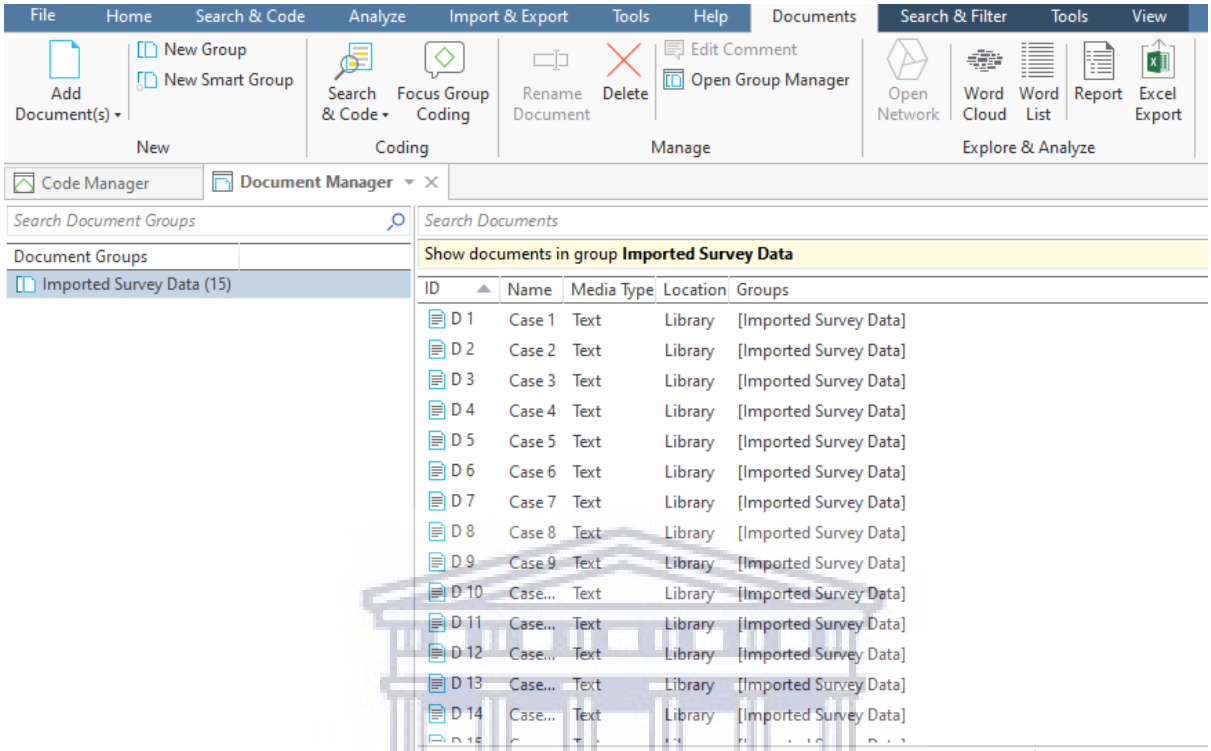
Long answer text

Are there any specific technologies you would like to see and use on campus? For example: interactive whiteboards.

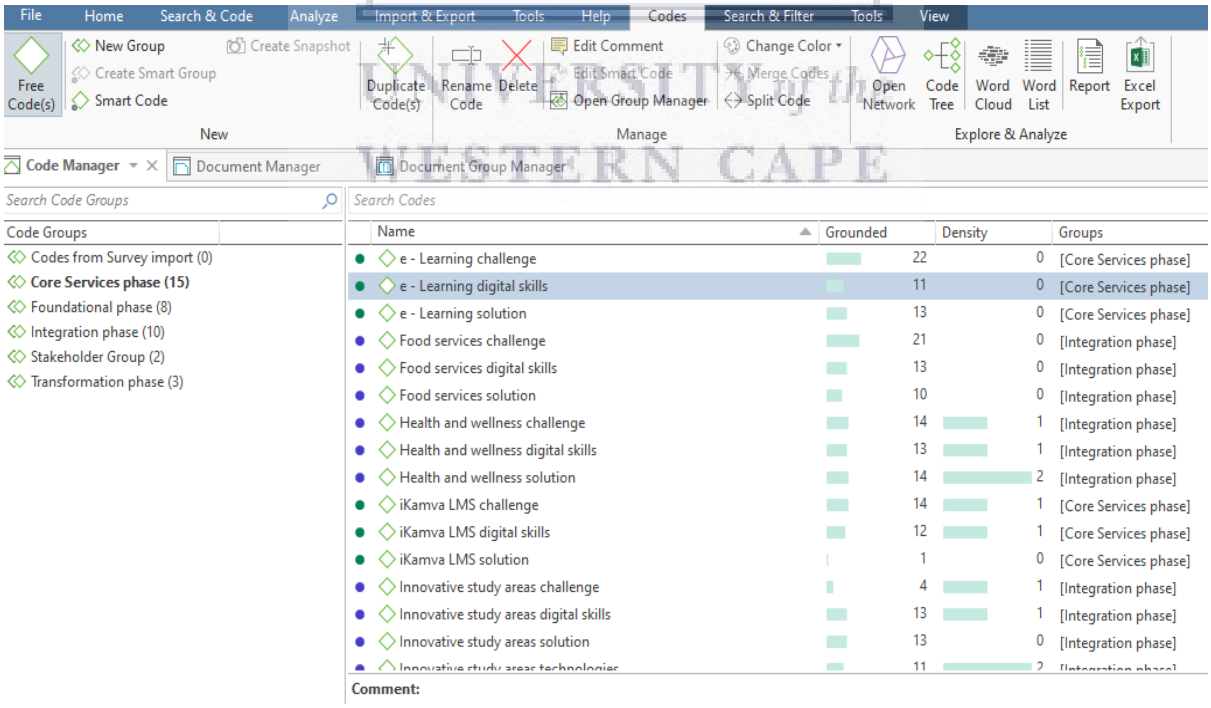
Long answer text

Appendix E: Screenshots taken from Atlas.ti version 9 (qualitative data analysis)

Screenshot of documentation uploaded to Atlas.ti.

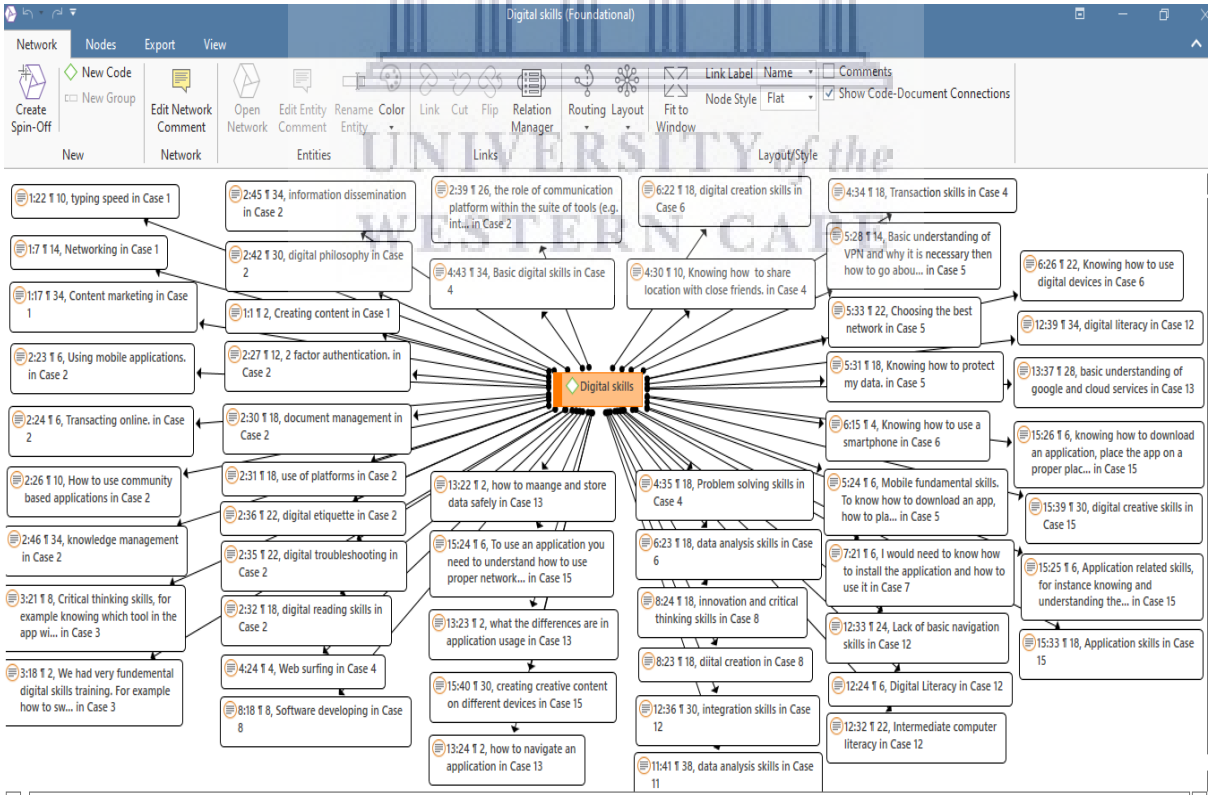


Screenshot of codes generated.

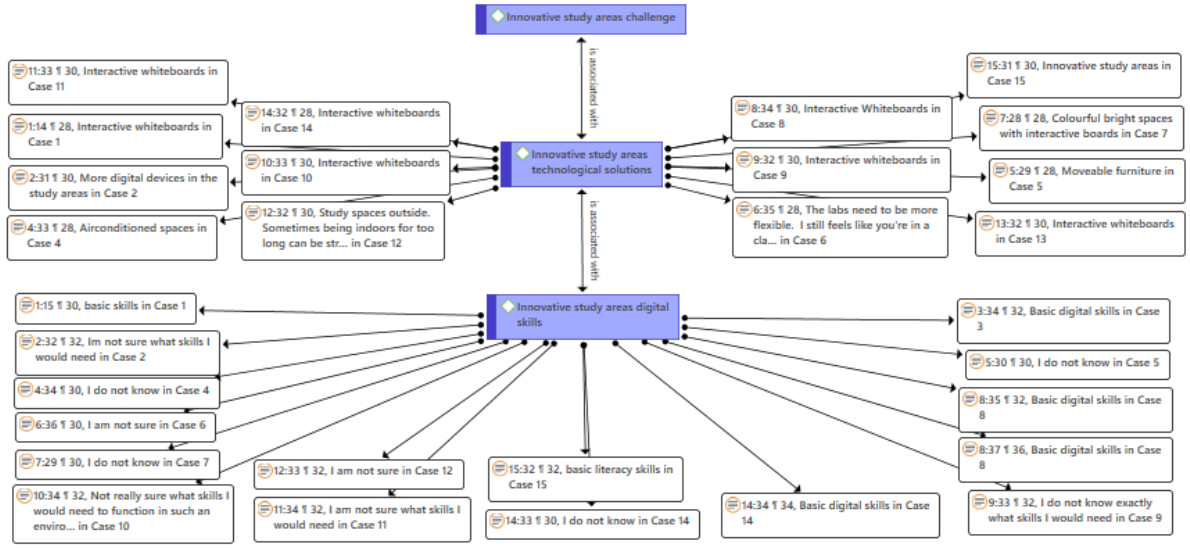


Network of codes related to smart campus transitional phases.

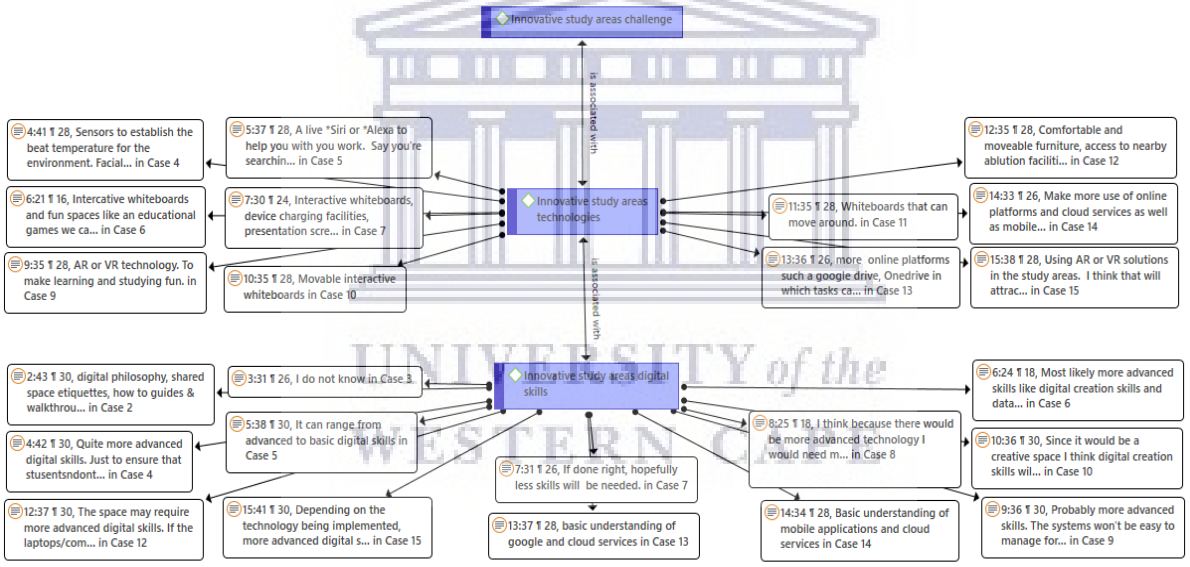
All the digital skills mentioned by the respondents



Iteration 1 of Innovative study areas.



Iteration 2 of Innovative study areas.

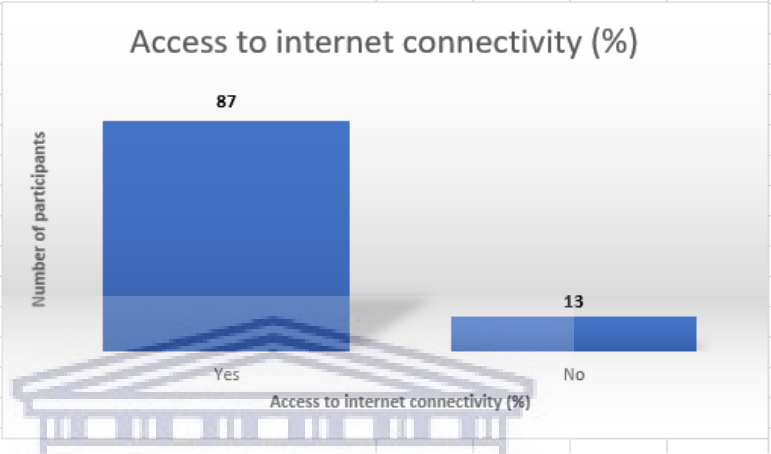


Appendix F: Screenshots taken of Excel sheets (quantitative data analysis)

Foundational challenges related to internet access.

F2. Q2 Do you have access to internet connectivity at your residential address?
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
No
Yes
Yes
No
Yes

Internet Connection Totals		
Yes	13	87
No	2	13



Foundational challenges related to basic digital skills.

	Basic digital literacy skills					
	F3. Q3 How would you rate you	F3. Q4 How would you rate yo	F3. Q5 How would you rate	F3 Q6 How would you rate your current ba	F3. Q7 How would you rate	F3. Q8 How would you rate your current bas
	Very skilled	Very skilled	Highly skilled	Very skilled	Very skilled	Highly skilled
	Very skilled	Very skilled	Highly skilled	Somewhat skilled	Not very skilled	Highly skilled
	Very skilled	Highly skilled	Highly skilled	Somewhat skilled	Very skilled	Highly skilled
	Highly skilled	Very skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled
	Very skilled	Highly skilled	Highly skilled	Very skilled	Highly skilled	Highly skilled
	Somewhat skilled	Somewhat skilled	Very skilled	Very skilled	Very skilled	Highly skilled
	Very skilled	Very skilled	Highly skilled	Somewhat skilled	Somewhat skilled	Highly skilled
	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled
	Very skilled	Highly skilled	Very skilled	Very skilled	Somewhat skilled	Highly skilled
	Very skilled	Very skilled	Very skilled	Somewhat skilled	Very skilled	Very skilled
	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled
	Very skilled	Very skilled	Very skilled	Somewhat skilled	Highly skilled	Somewhat skilled
	Very skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled
	Highly skilled	Highly skilled	Very skilled	Very skilled	Very skilled	Very skilled
	Expert level (Specialised trainir	Expert level (Specialised train	Expert level (Specialised tr	Expert level (Specialised training)	Highly skilled	Expert level (Specialised training)

	Basic digital Skill: Problem sol	dic digital skill: Transac	ital skill: Handling in	asic digital skill: Communicatio	igital skill: Content C	Basic digital skill: Personal life
Expert level (Specialised training)	1	1	1	1	0	1
Highly skilled	4	7	9	4	7	11
Very skilled	9	6	5	5	5	2
Somewhat skilled	1	1	0	5	2	1
Not very skilled	0	0	0	0	1	0
Not skilled at all	0	0	0	0	0	0
No knowledge of skill	0	0	0	0	0	0

Foundational challenges related to user skills.

	User skills								
	F4 Q9 How would you rate yo	F4. Q10 How would you rat	F4. Q 11 How would you	F4 Q12 How would you ra	F4. Q13 How would you rate y	F4 Q14 How would you	F4. Q15 How wou	F4. Q16 How would	F4. Q17 How would you rate
	Very skilled	Not very skilled	Highly skilled	Very skilled	Highly skilled, Very skilled	Very skilled	Highly skilled	Highly skilled	Highly skilled
	Somewhat skilled	Somewhat skilled	Highly skilled	Very skilled	Not very skilled	Not very skilled	Very skilled	Somewhat skilled	Very skilled
	Very skilled	Somewhat skilled	Highly skilled	Very skilled	Very skilled	Somewhat skilled	Highly skilled	Somewhat skilled	Not very skilled
	Highly skilled	Somewhat skilled	Highly skilled	Very skilled	Very skilled	Somewhat skilled	Somewhat skilled	Very skilled	Highly skilled
	Very skilled	Not very skilled	Very skilled	Very skilled	Not very skilled	Not very skilled	Highly skilled	Somewhat skilled	Very skilled
	Very skilled	Somewhat skilled	Very skilled	Very skilled	Not skilled at all	Somewhat skilled	Very skilled	Very skilled	Very skilled
	Very skilled	Very skilled	Very skilled	Very skilled	Somewhat skilled	Somewhat skilled	Very skilled	Somewhat skilled	Very skilled
	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled
	Very skilled	Very skilled	Highly skilled	Very skilled	Not very skilled	Somewhat skilled	Very skilled	Very skilled	Not skilled at all
	Very skilled	Somewhat skilled	Somewhat skilled	Very skilled	Somewhat skilled	Somewhat skilled	Very skilled	Very skilled	Highly skilled
	Highly skilled	Very skilled	Highly skilled	Highly skilled	Highly skilled, Very skilled, Son	Somewhat skilled	Highly skilled	Very skilled, Somev	Highly skilled
	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Very skilled	Somewhat skilled	Somewhat skilled	Very skilled	Somewhat skilled
	Highly skilled	Very skilled	Highly skilled	Highly skilled	Very skilled	Very skilled	Very skilled	Very skilled	Very skilled
	Highly skilled	Very skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Somewhat skilled	Highly skilled
	Expert level (Specialised trani	Expert level (Specialised tra	Expert level (Specialised t	Highly skilled	Highly skilled	Highly skilled	Highly skilled	Expert level (Specia	Expert level (Specialised trar

	Basic user skill: Word	Basic user skills: Spre	Basic user skills: W	Basic user skill: Coll	Basic user skill: Privacy	Basic user skill: S	Basic user skil	Basic user skill	Basic user skill: Ethica
Expert level (Specialised trainin	1	1	1	0	0	0	0	1	1
Highly skilled	6	2	10	6	3	3	7	2	6
Very skilled	7	5	3	9	4	2	6	6	5
Somewhat skilled	1	5	1	0	2	8	2	5	1
Not very skilled	0	2	0	0	3	2	0	0	1
Not skilled at all	0	0	0	0	1	0	0	0	1
No knowledge of skill	0	0	0	0	0	0	0	0	0

Responses related to foundational and core services challenges.

F7. Q22 Do yo	%	F7. Q23 Do you think opt	%	F7. Q24 If	%	C2. Q26 H	%	C2. Q27 D	%	C2. Q29 D	%	C3. Q31 A	%	C3. Q32 D	%	C3. Q34 D	%	C4. Q37 D	%	C4. Q39 D	%
Yes		Yes		Yes		No		I do not know		I do not know		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		Yes		I do not know		Yes		Yes		Yes		I do not know		Yes		Yes	
Yes		Yes		Yes		No		Yes		I do not know		No		Yes		I do not know		Yes		Yes	
Yes		Yes		Yes		Yes		I do not know		I do not know		Yes		Yes		I do not know		Yes		Yes	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		No		Yes		Yes		Yes		Yes		I do not know		Yes		Yes	
Yes		Yes		Yes		Yes		I do not know		I do not know		Yes		I do not know		I do not know		Yes		Yes	
Yes		Yes		Yes		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		Yes		I do not know		I do not know		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		I do not know		Yes		Yes	
Yes		Yes		Yes		Yes		No		Yes		No		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		No		No		Yes		No		I do not know		Yes		Yes		Yes	
14	93	15	100	15	100	9	60	8	53	10	67	12	80	13	87	9	60	15	100	15	100
1	7	0	0	0	0	6	40	2	13	0	0	3	20	0	0	0	0	0	0	0	0
								5	33	5	33	0	0	2	13	6	40	0	0	0	0

Responses related to the integration and transformation challenges.

C5. Q42 D	%	C5. Q44 D	%	C6. Q46 H	%	C.5 Q47 D	%	C5. Q49 D	%	I1. Q51 Dc	%	I1. Q52 Dc	%	I1. 54 Do	%	I3. Q61 Ha	%	I3. Q62 Dc	%	I3. Q64 Dc	%	S1. Q66 V	%
No		Yes		Yes		Yes		Yes		No		I do not know		I do not know		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		No	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		No	
Yes		Yes		Yes		I do not know		No		Yes		Yes		Yes		No		I do not know		I do not know		Yes	
Yes		No		No		Yes		Yes		Yes		Yes		Yes		No		Yes		Yes		No	
Yes		Yes		Yes		Yes		Yes		I do not know		I do not know		I do not know		Yes		Yes		Yes		No	
Yes		I do not know		Yes		No		Yes		Yes		Yes		Yes		No		I do not know		I do not know		No	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		No		Yes		Yes		Yes	
Yes		I do not know		Yes		I do not know		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Yes		Yes		I do not know		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		No	
Yes		Yes		Yes		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
I do not know		No		Yes		No		Yes		Yes		Yes		Yes		Yes		Yes		Yes		No	
Yes		I do not know		No		Yes		Yes		I do not know		I do not know		Yes		No		I do not know		Yes		Yes	
12	80	10	67	12	80	9	60	14	93	12	80	12	80	13	87	10	67	12	80	13	87	8	53
2	13	2	13	2	13	4	27	1	7	1	7	0	0	0	0	5	33	0	0	0	0	7	47
1	7	3	20	1	7	2	13	0	0	2	13	3	20	2	13	0	0	3	20	2	13	0	0