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Digital Skills Colloquium 2020

Enhancing Human Capacity for Digital Transformation

Editors: **T Mawela, H Twinomurinzi, NT Msweli, V Tau, T Rabindhnath**

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Digital Skills 2020 Colloquium and Postgraduate Symposium

Enhancing Human Capacity for Digital Transformation: It is about people

TENDANI MAWELA

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Preface

The Digital Skills 2020 Colloquium and Postgraduate Symposium was held on 12-13 March 2020 at the Birchwood Hotel and OR Tambo Conference Centre in Boksburg, Gauteng. It was hosted by UNISA in collaboration with the National Electronic Media Institute of South Africa (NEMISA). A total of 415 delegates registered for the Colloquium. The Colloquium brought together various leaders and participants from government, industry, academia and the international community all of whom are working towards addressing the triple challenges of poverty, unemployment and social inequality through digital skills.

The theme for the Digital Skills 2020 Colloquium and Postgraduate Symposium was “Enhancing Human Capacity for Digital Transformation: It is about people”. It is widely accepted that current digital changes that are sweeping through the world are significantly altering the environment in which every organisation, including government, is operating. The scale and scope of the change is what makes all the difference. The way in which organisations respond to these environmental changes will determine their survival. The nature of a digitally transformed organisation cannot be foretold as every organisation will respond according to their local and global environment. There are, however, some uncomfortable realities; manufacturing jobs will not be reinstated, and even if they did, the manufacturing industries are necessarily more capital and not labour intensive (Stiglitz, 2017). Globally, we are experiencing rising unemployment and income inequality as well as increased demand for high skilled labour (Glenn, Florescu & Project, 2019).

Accordingly, the Colloquium sought to explore the role played by digital skills in our rapidly transforming realities. The event attracted full academic research papers, case studies, research work that still in progress and practitioner reports and models that portray the NEMISA collaborative ethos involving government, industry and other sectors. Some plenary sessions and guest speakers shared insights on topics such as emerging technologies, blockchain, machine learning, gamification in education, application of 3D printing, upscaling of ICT for development programmes and citizen online safety.

The Honourable Minister Stella Ndabeni-Abrahams of the Department of Communications and Digital Technologies (DCDT) delivered a key note address that highlighted the need to integrate technology into various levels of education, and particularly within our primary schools to prepare future generations for a digital society.

The Vice Chancellor’s plenary, chaired by Dr Colin Thakur of the Durban University of Technology, explored the changing role of institutions of higher learning in preparing various groups including students, graduates, the unemployed and their surrounding communities for the changing world of work and industry demands in the context of the Fourth Industrial Revolution (4IR).

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Prof. Chris Adendorff, the 4IR Commissioner and NEMISA Board Programme and Academic Committee (PAAC) chair, delivered a keynote presentation that highlighted the need to reimagine the future of education and work, taking into account the advent of the 4IR. He outlined that the various technologies of the 4IR will bring changes that will drastically reshape the world as we know it. In this future an important skill for the labour market will be tech-saviness since the majority of jobs will involve the Science, Technology, Engineering and Maths (STEM) disciplines.

The Colloquium received a total of twenty nine submissions from fifteen institutions across the breadth and length of South Africa. Of these, five were rejected, twelve were accepted as full papers, and four were accepted as either short papers or abstracts and eight as poster presentations for the Postgraduate Symposium.

Full Research Papers

Sharol Newman & Osden Jokonya focused their efforts on the adoption of smart technologies the in the higher education sector. The authors sought to understand the factors and drivers behind the implementation of smart libraries at universities. In the same vein, Diana Welbotha Hollong & Osden Jokonya reviewed the adoption of smart classrooms at universities and colleges through the application of the Technological, Organizational and Environmental (TOE) framework for purposes of analyzing the collected data. The two papers highlighted technological factors as the main point needing consideration in the adoption of smart solutions at institutions of higher learning.

Kgomotlokoa Linda Thaba-Nkadimene & Allsie Mogatli investigated experiences and perceptions of educators regarding the use of technology in rural based schools in the Limpopo Province of South Africa. The study was qualitative and interpretive in nature and collected data from secondary schools in the said location. The data suggest improved student engagement and learning as one of the benefits that is derived from technology for teaching. The challenges noted include distractions from social media and a lack of digital skills and pedagogies. A lack of access to technologies was also cited as challenge in rural areas. Key recommendations for practice are a focus on improving access to the relevant technologies and training on educational technologies for the educators.

Using a systematic literature review, Anass Bayaga drew attention to the threat of cybersecurity for e-government in developing countries such as South Africa. The second paper presented by Anass Bayaga and Michael Kyobe examined the acceptance of e-government services by citizens. The authors elevate the notions of perceived ease of use, perceived risk and cultural dimensions in their discussion of factors related to public e-services.

Takalani Rasalanavho & Hossana Twinomurinzi's paper, which is underpinned by an interpretivist paradigm, examined the implications of the 4IR on digital government initiatives.

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The study reviewed the South African National Treasury Department and found that various 4IR technologies including virtual reality, blockchain technology and artificial intelligence are relevant to the Department. However the potential of these technologies is challenged by the limited digital skills to support their adoption and effective implementation.

Elias Tabane reported on the application of machine learning and data mining in the health context. The study serves as a contribution to the smart health literature by offering an approach to predict heart disease through data mining and machine learning techniques.

Kayakazi Taleni & Hossana Twinomurinzi presented a case study on Eskom, South Africa's largest electricity producer. The study investigated digital transformation at Eskom's ICT Department. The results indicated that, although ICT departments are typically expected to lead digital transformation initiatives, there is often no clear strategy or guidelines on how such a transformation may be successfully executed.

In times of high unemployment, many may turn to the gig economy to explore employment opportunities. Lovemore Khambane & Pitso Tsibolane analyzed the skills required to take advantage of the growing gig economy. The study highlighted the importance of technical and interpersonal skills. The authors identified digital skills that governments should focus on developing to improve employability of citizens in the digital gig economy.

The research study presented by Mnoneli Nogwina, Sibukele Gumbo & Ndiyakholwa Ngqulu was aimed at gaining a deeper understanding of the ICT training needs and ICT infrastructure available at organisations that work with persons with disabilities in the Eastern Cape province of South Africa. The outcomes of the workshop that was facilitated by the authors indicate that current e-skills courses cannot be used without incorporating accessibility tools when training persons with disabilities. Therefore, mainstream computer training programmes need to be reconfigured so that they are aligned to the training needs of persons with disabilities.

4IR readiness was one of the topics that featured at the Colloquium. Research undertaken by Thobani Mhlongo & Samuel Ssemugabi sought to gain a deeper understanding of the readiness of South Africans for the 4IR as it relates to digital literacy and e-skills. Through a cross sectional survey of citizens, it was established that young adults in a sampled community possessed above average e-skills, and the participants were thus considered ready for the 4IR.

Short Papers and Abstracts

Gugulethu Baduza & Caroline Pade-Khene brought to the fore the requirement for a scalability assessment framework for ICT for Development projects in the digital economy. The authors submit that the key themes that are essential for the assessment of the scalability of an ICT4D include: an understanding of the composition of stakeholders; the sustainability of resources; resilience; and model feasibility.

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Issah Ngomane & Duduxile Masuku investigated the security challenges associated with Internet-of-Things (IoT) devices. In addition, the paper offers potential solutions for improving currently available mitigation strategies.

A systematic literature review on digital financial services in Kenya and how agents comply with the stipulated legislation and standards was conducted by Rebecca Njuguna & Adheesh Budree. Through this review, a conceptual framework that can be used for empirical compliance studies among digital financial services agents was proposed.

Annelie Jordaan & Antoinette Lombard designed a Media Literacy Framework that is informed by identified media literacy indicators within the South African context, which can be used as guidelines for the development of a Media Literacy curriculum.

Postgraduate Symposium

The Postgraduate Symposium offered exposure for a variety of research projects. Zizipho Macanda investigated the notion of business process management in the South African government sector. Roger Wahl conducted an experiment to explore the prospects of innovations such as IoT and how IoT can be integrated into self-regulated vehicles and other applications.

Nosipho Mavuso proposes the application of big data analytics to support the career choices of high school learners. Mlungisi Nxumalo's project is geared towards conducting a study that explores the effect of introducing interactive and collaborative social learning into an online learning environment on participation and successful completion of online courses.

Emil Arthur van der Poll focused on using gamification for collaborative learning within Information Systems education programmes. The study followed an action research methodology and advanced that gamification holds some promise for bridging relationships between people from different socio-cultural backgrounds and contributing to Information Systems education.

Moses Sithole's poster presentation tackled the role of ICT within the agricultural sector of South Africa. In particular, the research defines the concept of digital agriculture, explores the role of digital agriculture in ensuring sustainable agriculture and also examines the factors influencing the adoption of digital agriculture by smallholder farmers.

Lloyd Modimogale's submission highlights several challenges posed on the nature of work and skills requirements in the coal mining sector by modernisation and digitalisation trends. Accordingly, the research study aims to investigate the skills development approaches that may support the reskilling of coal miners for the 4th IR.

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RESEARCH PAPERS

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INVESTIGATING FACTORS INFLUENCING THE ADOPTION OF SMART LIBRARIES AT UNIVERSITIES

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ABSTRACT

Aim/Purpose	The aim of the study is to explore the factors that affect the adoption of a smart libraries at universities.
Background	Studies on factors that influence the adoption of smart libraries among universities are limited. Therefore, a need exist for a deeper understanding of these that influence and facilitate the successful implementation of university smart libraries.
Methodology	The systematic literature review methodology was used to establish the factors influencing the adoption of smart libraries at universities. The research study adopted the Technological, Organizational and Environmental (TOE) framework to provide a holistic view pertaining to factors that influence the adoption of smart library at universities. Furthermore, content analysis was adopted in this research study to analyse work on the adoption of smart libraries at universities that was published between 2013 and 2018.
Contribution	This research paper contributes to the limited body of knowledge on factors that influence the adoption of smart libraries at universities. Specifically, an attempt will be made to close the existing gap relating to the underlying factors behind the adoption of smart libraries at universities.
Findings	Results emanating from this research study suggest that the technological factors are the most impactful factors in respect of the adoption of the smart libraries at universities. In addition, cloud computing is perceived to play a critical role in the adoption of smart libraries at universities.
Recommendations for Practitioners	From the practitioner perspective, it is recommended that due consideration be given to TOE Framework since it is very useful for assisting Practitioners to gain a better understanding of the underlying factors influencing the adoption of smart libraries at universities.
Recommendations for Researchers	It is recommended that researchers should put more emphasis on using empirical studies; unfortunately, the current study is limited since it was based on secondary data. Different research methodologies and methods may also prove to be important for future research.
Impact on Society	The study will provides some insight to some of the key factors that influence the adoption of smart libraries at universities and will therefore benefit academic institutions of higher learning that are planning to embark on the journey of adopting smart libraries. In addition, results emanating from this research study will act as a readiness check for universities before making a decision to adopt smart libraries.
Future Research	Future research should focus on the collection and analysis of the relevant empirical data and different frameworks should be developed to gain a deeper

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understanding of the factors affecting the adoption of smart libraries at universities.

Keywords Smart Library; Academic Libraries; Big Data; Cloud Computing; IoT; Artificial Intelligence; TOE Framework.

INTRODUCTION

The three-world framework was initially developed in *Understanding Social Research,* which was written by J Mouton (1996). As indicated by Mouton (1996), world 1, refers to "the world of everyday life and lay Knowledge". This will be beneficial for universities, as it will create awareness about the need for adopting the smart campus concept. Universities are ranked based on the rate they adopt ICT solutions. This study is beneficial for universities that are determined to boost their world ranking and be of excellent service to its clients, the students. A content analysis focusing on institutional needs, will provide sufficient answers to the research problem. The research problem that underpins the research is that several studies have been conducted regarding smart libraries; however, limited work has been carried out regarding the factors that determine the adoption of smart libraries among universities (Sancheti & Hajare, 2017). This study aims to fill in this gap. This research is guided by the following main research question: What are the factors affecting the adoption of smart libraries among universities? The next section reviews literature on factors that affect the adoption of smart libraries among universities.

LITERATURE REVIEW

Atif, Mathew and Lakas (2015) state that a smart ecosystem may be viewed as a digitally improved physical world where ubiquitous objects and spaces are intellectually conscious, coupled with the responsiveness of the environment and its occupants. On the other hand, Lopes & Oliveira (2017) define a smart city as "a city which has specified its purpose to use information and communication technologies (ICT) to convert its approach in several areas like governance, energy buildings, mobility, etc." Smart universities are part of the ecosystem of a smart city. According to Hayikader et al. (2015), a smart university is, in essence, first defined by the term "smart". The term "smart" can be defined as "a strategic approach to economic development through targeted support to Research and Innovation" (Kempton et al., 2013). Baryshev et al. (2015) define a smart library as "a set of various electronic resources, accompanied by specialized library services, which are provided by the use of information and communication technologies". In addition, the authors stated that formerly technology is built on information and knowledge, and is converted into technologies that are built on interaction and exchange of experience, which relate to smart technologies (Baryshev et al., 2015). Aleksandrovich & Ivanovna (2016) have stated that "Smart library is a library provided services, which are interactive, innovative, informative, actual, changing and international".

OVERVIEW OF SMART LIBRARY TECHNOLOGIES

Smart library technologies result from the integration of various technologies such as big data, internet of things, cloud computing and artificial intelligence. Therefore, these technologies are discussed individually and briefly in the subsections that follow. It is well known that the advancement and integration of these technologies pose serious concerns regarding the invasion of privacy of the users of these technologies. For this reason, information on the users' privacy has also been included as part of the discussion on smart library technologies.

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Big Data

A study undertaken by Ben Ahmed et al. (2014), suggests that big data can be defined in terms of three dimensions, namely: volume, velocity and variety. Integration of big data into universities and the quest to become a smarter university has been a hot topic area of the decade (Ben Ahmed et al., 2014). The use of big data in universities is popular since all information in recent times is digitalized (Hayikader et al., 2015). Simović (2018) is of the view that several forms of data are currently created at a fast rate. Apparently big data can be described as one of the ultimate technology movements in 2017 (Panetta et al., 2018). The use of big data in libraries can, therefore, can towards assisting researchers to conducting their research and the library staff to manage the vast amounts of data collected by libraries (Simović, 2018). To this end, big data can contribute towards assisting libraries becoming smart libraries.

Internet of Things (IoT)

IoT has evolved as the movement in the advancement of the Internet. Service efficiency and security of academic libraries can be improved through IoT's solutions. IoT is an emerging technology that has the benefit of inducing the use of technology among patrons through availing new developing and efficient services more rapidly and conveniently (Nag & Nikam, 2016). Aleisa & Renaud (2016) is of the view that the IoT usually refer to Internet-enabled objects working together to attain specific goals. There are a variety of such objects, such as radio frequency Identification (RFID), sensors and smartphones. The IoT was designed to improve people's lives. Users can seamlessly share information within a network. This varies from person-to-person, machine-to-person or machine-to-machine. The IoT capitalizes on convenience (Fink et al., 2015). According to Jadhev et al. (2017), a smart environment established through RFID technologies provides several benefits, some of which can be viewed in the context of a university. In addition to claiming that the adoption of RFID technology appears to enhance the competencies of library services at universities, the authors suggest that the best-known advantage of such a developed system is due to economically feasible features. The system apparently works in conjunction with RFID reader boards, control circuits and database servers thus enabling such technologies to contribute to the move towards a smart library.

Cloud Computing

In essence, cloud computing is the collection of computing software and services that can be retrieved through the Internet rather than residing on a desktop or internal server. Traditional computing costs more than cloud computing, and this tends to increase the operational costs of libraries. Cloud computing carries a minimal cost or is virtually free in the case of open source (Nag & Nikam, 2016). According to Wasike & Njoroge (2015), there are three primary service models of cloud computing, namely: Software as a service (SaaS); Platform as a Service (PaaS); and Infrastructure as a Service.

As far as Jeong, Kim & Yoo (2013) are concerned, cloud computing can be viewed as a relatively new Information Technology (IT) service model for conveying and making provision for computing resources such as but not limited to networks, servers, storage and applications; also, cloud computing is offered as a service over the internet and around the globe for twenty four hours around the clock. Furthermore, cloud computing has gained much attention in the field of education due to the possibility of delivering economical, securable, reliable and

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sharable educational services (Jeong et al., 2013). The low costs, least specialized skill necessities, adaptable and dynamic utilization of cloud computing makes it less demanding for technology adopters to change to cloud computing (Nkhoma & Dang, 2013).

In the UK and USA, numerous universities and educational institutions have been adopting cloud computing. In addition to cost saving benefits, cloud computing has been improving the effectiveness and accessibility of educational services (Jeong et al., 2013). Cloud computing can assist libraries in exploring and developing their next generation of library catalogues. Cloud computing has the potential to advance service productivity and visibility of library collection and management services (Nag & Nikam, 2016). Based on the findings of a study undertaken on the adoption of cloud computing at a university library in India, Yuvaraj (2015) concluded that the perceived benefits of cloud computing are insufficient to persuade organizations to migrate to the cloud from traditional computing models. Furthermore, Yavaraj (2015) has argued that in order to encourage the development of cloud computing adoption among university libraries, it is vital to increase the alliances with cloud service providers and have the a clear requisite cloud legislation in place.

Artificial Intelligence

Yao, Zang & Chen (2015) defines Artificial Intelligence (AI) as “the science and engineering of making intelligent machines, especially intelligent computer programs”. The additionally posit AI as an academic field of study that examines the aim of producing intelligence. Furthermore, the adoption of applicable AI technologies into real-time virtual reference services is commonly considered as a favourable new reference service approach. On the other hand, Fernandez (2016) claims AI as a type of technology that may influence libraries in the areas of search, educational technology and logistics. Primarily, AI is a set of technologies that endeavour to enable computers to solve problems in a more intelligent manner than previously thought possible. Computers have the advantage over humans in that they can process and captivate certain types of data much faster and more accurately.

Privacy Concerns

Gressel (2014) has alluded to the escalating fear of privacy invasion. It is inevitable to avoid the technologies that empower these invasions. Furthermore, some libraries in the USA have the reputation of not handing over information to the government; some libraries destroy user’s information as part of their quest to safeguard the privacy of the users. The advancement of technology poses a major threat to user’s privacy. Therefore it can be said that technology is the biggest enabler of privacy concerns, and libraries need to take the responsibility of preventing such invasions. Furthermore, social media and consumerism also play a role in invading the privacy of library patrons. As a result, libraries need to cautiously reconsider how their actions will affect library patrons. According to a study done by Gressel (2014), during 2012, the tweeting by the Harvard University library of books that have been checked out by its patrons caused major privacy concerns. Libraries are forced to keep up with the latest technologies and in doing so are prone to create a privacy policy that might not be in the best interest of its patrons. In addition to government and social media interference, consumerism is also taking advantage of the library patron’s information. For example, when patrons make use of the libraries search engines, such information may be shared among vendors (Gressel, 2014). However, with respect to IoT, user’s privacy concerns are a big concern due to the invisibility of data collection, usage and sharing. Hoy (2016) has mentioned that libraries have always been a supporter of privacy and free access to information, and thus any system that

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keeps a record and records the locations and activities of its users is a possible threat to that privacy.

THEORETICAL FRAMEWORK

According to Oliveira and Martins, (2011) the Technological, Organizational and Environmental (TOE) framework was developed in 1990 by Tornatzky and Fleischer. The emphasis on the framework was the adoption of technological innovation. Technology adoption is the initial use or acceptance of a new technology or new product. Numerous theories and models such as the TOE framework describe technology adoption. According to Gandwar, Date & Raoot (2014), several studies have shown that the TOE framework has established itself as the most well-known theoretical viewpoint on IT adoption. In addition, Gangwar, Date & Raoot (2014) have listed the three types of environments that may influence technological innovation adoption and implementation processes. These three constructs of the TOE framework are as follows:

- **Technological environment**: This involves the variables that affect an individual, an organization and an industry's adoption of innovations.
- **Organizational environment**: This refers to descriptive measures related to organizations such as firm scope, firm size, managerial beliefs and others. Adoption tendency is subject to formal and informal intra-organizational mechanisms for communication and control, along with the resources and innovativeness of the organization.
- **Environmental environment**: This environment is centred on areas in which a firm conducts its business operations, with the priority given to external factors influencing the industry such as government incentives and regulation (Gangwar, Date & Raoot, 2014).

RELATED STUDIES

Several studies exist on smart libraries as stated in the research problem; however, based on the literature search through various databases no studies exist on using the TOE framework in the study of smart library. This study thus contributes largely to the research world. Bansode et al., (2016) conducted a study regarding "smart library using near field communication (NFC)", the study suggested that the project intended to provide improved and efficient systems. The wireless system was deemed reliable and thus the proposed method provided a safe, secure and well-organized way of smart library systems. Furthermore, Khuntia, Mishra & Ramesh (2016), conducted a study regarding the technologies applicable to smart library. The authors discussed the usefulness of technologies, impact on society, amongst others, pertaining to smart library. Technologies discussed were cloud computing, RFID and web 2.0

RESEARCH METHODOLOGY

In order to determine the factors that affect the adoption of smart libraries at universities and thus ensure that all of the research objectives are met, the TOE framework was adopted and applied. To achieve the research objective, the researcher conducted an exploratory study. The fundamental purpose of conducting the exploratory research is to find any underlying associations between the factors or variables that connect to the research problem (Babbie et al., 2001). Since this study is aimed at an analysis of the existing data, a systematic literature

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review was therefore considered to be the most appropriate design for this study. According to Mouton (p. 108, 1996), “the rationale for a research design is to plan and structure a research project in such a way that the eventual validity of the research findings is maximised through either minimising or, where possible, eliminating potential error”. The research design type will, therefore, enable the researcher to identify the overall trends, fresh leads and assist in identifying unexpected differences in a wide range of possible solutions. The key steps that need to be taken in systematic literature review studies are outlined in Figure 1. These steps are visible throughout the remaining part of this research study.

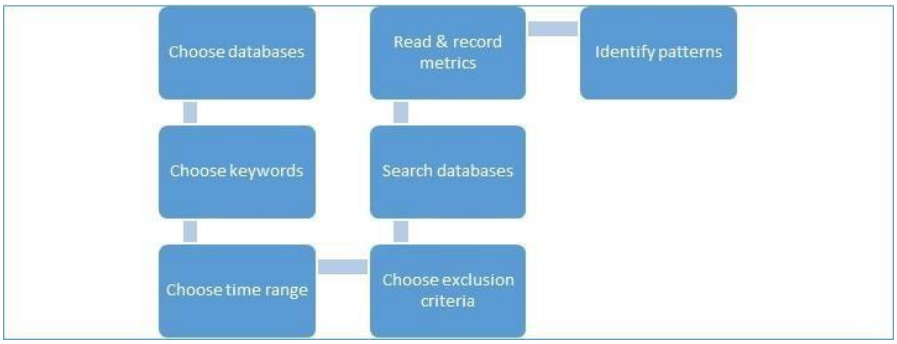

Figure 1. Systematic Literature Review steps

UNIT OF ANALYSIS

Babbie et al. (2001) has acknowledged that “the unit of analysis refers to the WHAT of your study: what object, phenomenon, entity, process or event you are interested in investigating”. The unit of analysis for the proposed study can be derived from World 1. The unit of analysis type for the proposed study is institutions and the unit of analysis for the study is the literature of the study. The constructs from the TOE framework was used to search for relevant literature. The literature provided the answers to the research. The motivation is because the nature of the research problem is based on academic institutions, and the use of a theoretical framework was therefore used. The constructs from the TOE framework aid in providing the answers to the research. The primary questions seek to find factors that will influence the adoption of smart campus technologies. Based on this, the unit of analysis is the constructs of the TOE framework, applicable to the study of smart library adoption at universities.

RESEARCH METHODS

Centred on the research question, problem and objectives, the appropriate research method selected is content analysis. The research used content analysis to analyse articles that were published between 2013 and 2018 on the subject of smart library adoption at universities. Rose, Spinks & Canhoto (2014) have described content analysis as an adaptable research approach applicable to a wide-ranging selection of written sources. A substantial amount of data can be analysed with computer software programs such as SPSS, which make content analysis desirable for this study. According to Haggarty (1996), “Content analysis is a research method which allows the qualitative data collected in research to be analysed systematically and reliably so that generalizations can be made from them in relation to the categories of interest to the researcher”. Content analysis can use qualitative (thematic) and quantitative (descriptive statistics) techniques for analysis of the data. In this research study, quantitative techniques were used for the analysis of the data.

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According to Leedy (1993), “Quantitative research methods are research methods dealing with numbers and anything that is measurable in a systematic way of investigation of phenomena and their relationships. It is used to answer questions on relationships within measurable variables with an intention to explain, predict and control phenomena”. Quantitative analysis techniques such as graphs, charts and statistics can assist the researcher to explore, present and examine relationships and trends within the data (Saunders, Lewis & Thornhill, p. 445 2009). Content analysis uses either inductive or deductive tactics to produce groupings or coding rules before converting qualitative data into quantitative data (Jokonya, 2015). An inductive approach consists of open coding and constructing groupings. Since a theoretical framework already exists in literature, the deductive approach was deemed the most appropriate for this study.

The TOE framework was used to form constructs from predefined categories. According to Gandwar et al. (2014), several studies have shown that the TOE framework has gained the reputation of being a well-known theoretical framework on IT adoption. The categories were selected based on existing published literature, which used the TOE framework in previous works. The inclusion and exclusion criteria for the selected publications chosen for the study are outlined in Table 1. Articles that did not match the inclusion criteria were not selected. Following the selection of articles, the constructs listed in Table 2 were used to search for the occurrence of each of the constructs in each article. In addition, synonyms were used if a particular keyword was not found. The following literature metrics that include all the relevant constructs as per the TOE framework was constructed in Microsoft Excel: author; year of publication research method; type of study; and theoretical framework. Subsequently, the excel data was exported to the SPSS statistical package for analysis. The frequencies of the data was run through the software and ‘One-Way-ANOVA’ test was conducted to determine the variances of the data. Lastly, SPSS was used to generate he requisite graphs for analysis.

Table 2: Exclusion and inclusion criteria

Instrument Development			
No.	**Criteria**	**Inclusion Criteria**	**Exclusion Criteria**
1	Language of articles	English is the preferred language of articles	Non- English articles
2	The time frame of journal articles	Journal articles published from 2013 to September 2018	Journal articles published prior to 2013
3	Relation to smart library	Strong relation to smart library adoption amongst universities.	Ambiguous/frail connection to smart library adoption
4	Study type	Only peer-reviewed journal articles	Opinions, book reviews and blogs

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Table 1: TOE Constructs

Constructs	Description
Technological Factors	Perceived benefits
	Technical compatibility
	Ease of use
	Privacy concerns
	Perceived usefulness
	Security threats
	Vulnerability
Organisational Factors	Library systems
	Library Spaces
	Smart library buildings
	Managerial support
	Internal perceived tech competence
	Organizational culture
	Perceived skills of librarians
	Technological readiness
Environmental Factors	Competitive pressure
	Technology service provider Standards
	Legislation and regulations
	Vendor capabilities
	Relationship with service providers
	Industry characteristics and market structure

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DATA SOURCES AND SAMPLING

The study looked at data from 2013 to 2018 from peer-reviewed journals and conference papers. Electronic databases and search engines such as AIS Library; Taylor Francis online, JSTOR, Scopus, Sage, Google Scholar, Emerald Journals, Science Direct and Research Gate were chequered for the relevant information. A total of 70 articles were selected based on the search criteria. Due to restrictions on some electronic databases, the study was limited to few accessible databases. A list of selected articles were sourced from the relevant databases for purposes of this research study Convenience sampling was utilised for the selection of the articles for this research study. Whereas Etikan, Musa & Alkassim (2016) and Dörnyei (2007), have asserted that "Convenience sampling is a type of nonprobability or non-random sampling where members of the target population that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate are included for the purpose of the study". Etikan et al. (2016) have maintained that the rationale behind the selection of convenience sampling is due to the fact that in research it is impossible to sample the entire population. For this reason, in this study, the researchers opted for a sampling technique with a process that involved in-convenience sampling; that is, a process involving searching for keywords in a scientific database. The desired keywords used involved terms such as, 'smart library'. The literature search revealed a total of 70 articles which fitted the study criteria.

DATA ANALYSIS

An existence of pre-defined themes in the selected published articles was identified. Predefined groupings and coding rules were utilised for the conversion of qualitative text into quantitative data. The conversion of qualitative text to quantitative data is vital for this study in order to produce quantitative statistics by means of the Statistical Package for the Social Science (SPSS) statistical package. Additionally, as part of the exploratory study, the transformed data was analysed using of the SPSS to produce (descriptive) frequency counts and inferential statistics (analysis of variance). In essence, the frequency of analysis was conducted. The qualitative data from the literature was manually coded to address the concern of inter-coder reliability. As pointed out by Jokonya (2015), reliability is the possibility that other scholars will yield identical results if the process for the generation of similar results is repeated. Furthermore, the manual coding procedure is reliant on the individual interpretation of the coder. To ensure reliability, the coding process was followed as per the coding rules. Inter-coder reliability was tested through the Cronbach alpha test with a sample of 20 articles and generated a reliability of (.85).

STUDY RESULTS

In this section, the results from data collected from 70 articles published between 2013 and 2018 on smart library adoption amongst universities are discussed. The section also details the demographic results of the study. Additionally it presents the frequencies of the technological, organizational and environmental factors from the 70 articles reviewed.

DEMOGRAPHIC DATA

Articles Distribution by Year

The distribution by year of articles published between 2013 and 2018 on smart library adoption at universities is depicted in Figure 4. The results from the cumulative percentage indicate that 40% of the articles were published between 2013 and 2016, and the balance was published

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between 2017 and 2018. An initial increase in the percentage of published articles was observed for the period 2013 – 2016; this was however followed by a subdued increase in 2017. In contrast, a rapid increase in the number of published articles was noted for 2018. The rapid increase in the number of publications is ascribed to increased research in the topic of smart libraries during 2018.

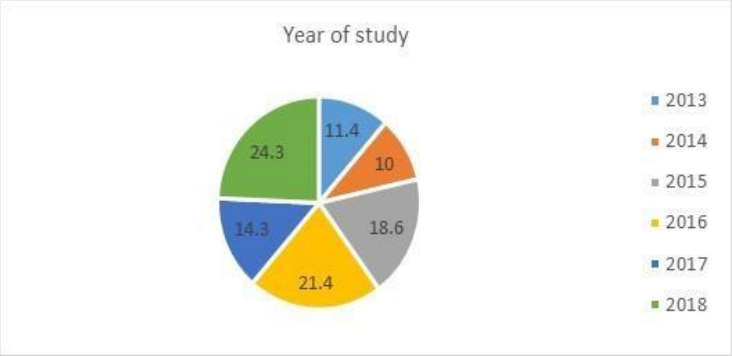

Figure 4: Distribution of published articles by year of study.

Articles Distribution by Region

The distribution of articles published between 2013 and 2018 on smart library adoption at universities in terms of regions (i.e. Africa, America, Asia, Australasia, Europe and the Middle East) is depicted in Figure 5. At 48.6%, Asia accounts for the most number of the articles published. A fair amount of articles were published in Europe (21.4%) and America (17.1%), with Africa and the Middle East lagging behind at 5.7% and 1.4%, respectively. It is therefore evident from the results of the study that Asia is the dominant region with respect to research conducted in the area of smart library adoption at universities.

Figure 5: Distribution of published articles by regions

Articles Distribution by Type of Study

The distribution of articles published between 2013 and 2018 on smart library adoption at universities by type of study is depicted in Figure 6. At 58.6% and 21.4%, it is evident from the results of this research study that case studies and surveys are, respectively, the most popular

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types of studies for investigating the adoption of smart libraries at universities. Very few studies have utilised systematic literature review (7.1%), comparative studies (2.9%) and literature review and Meta-synthesis (1.4%) to investigate this phenomenon.

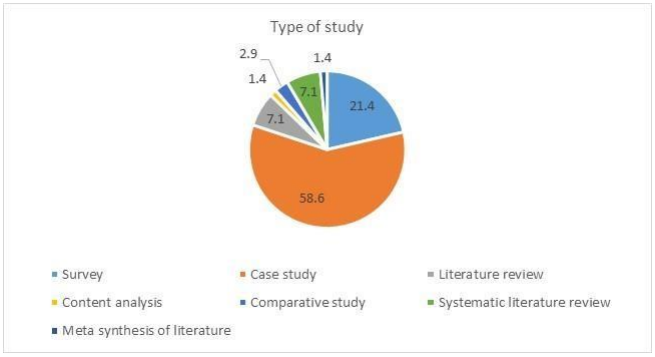

Figure 6: Distribution of published articles by type of study

Articles Distribution by Type of Research Methods

The distribution according to type of research methods of articles published between 2013 and 2018 on smart library adoption at universities shown in Figure 7. A substantial majority of the articles published used qualitative (74.3%) and quantitative (21.4%) methods, and only (4.3%) of the studies opted for the mixed-research methodology. Qualitative research methods are therefore used widely when conducting studies on the adoption of smart library at universities.

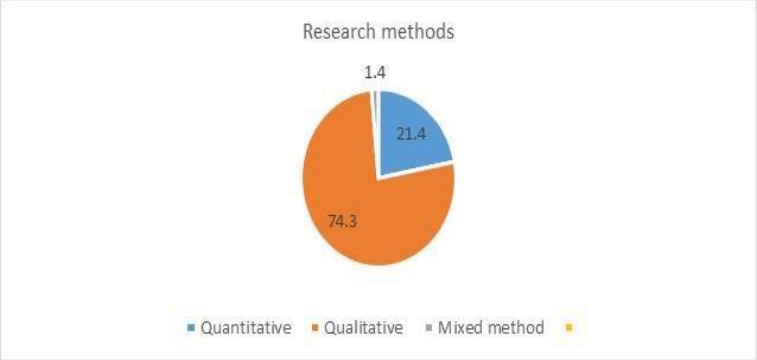

Figure 7: Distribution of published articles by research methods

FREQUENCIES OF TOE FACTORS

The TOE framework, which is regarded as the most well-known theoretical viewpoint on IT adoption (Gandwar, Date & Raoot, 2014), is composed of three that can influence technological innovation adoption and implementation processes. The frequency of the factors, which are related to the adoption of smart library at universities, are discussed individually in the subsections that follow.

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Technological Factors

This section seeks to answer the following research question:

> "*Which are the technological factors influencing adoption of smart libraries at universities?*"

Based on 70 published articles that were selected for this research study, the 117 frequency counts that are related to technological factors affecting the adoption of smart library adoption at universities are presented in Figure 8. Most of the articles mentioned perceived benefit (35.7%) and ease of use (34.3%) as technological factors influencing the adoption of smart library at universities. In addition, perceived usefulness (40%) was also noted as a factor influencing the adoption of smart library at universities. Technical compatibility was mentioned by 27.1% of the articles. Only 14.3%, 11.6% and 4.3% of the articles mentioned security threats, privacy concerns and vulnerability as technological factors influencing the adoption of smart library at universities. It is quite alarming that security threats, privacy concerns, and vulnerability scored such low frequencies because privacy and security were perceived by Hoy (2016) and Nag & Nikam (2016) as important factors at universities in general. The low technological frequencies recorded in this study may be due to a lack of research in the area of smart library adoption at universities.

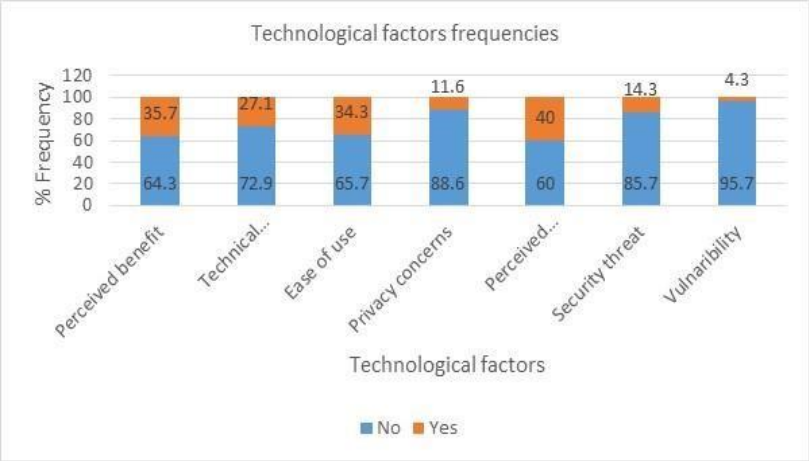

Figure 8: *Technological factors*

Organisational Factors

This section seeks to answer the following research question:

> "*Which organizational factors influence the adoption of smart libraries among universities?*"

A total number of 105 frequency counts related to organizational factors affecting the adoption of smart library adoption at universities were recorded. The frequency count related to the organizational factors found in the articles published between 2013 and 2018 are shown in Figure 9, and only 8.6% and 4.3% of articles mentioned smart library spaces and smart library buildings, respectively, as a resource influencing the adoption of smart library at universities. Most of the articles (38.6%) promote the smart library systems concept. Managerial support and internal perceived technology competency appeared in 2.9% and 37.1% of the articles, respectively. About 18.6 % of the articles mentioned the perceived skills of librarians as an

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organizational factor influencing the adoption of smart library at universities. Technological readiness appeared in 24.3% of the articles. It is quite alarming that organisational factors have such low frequencies.

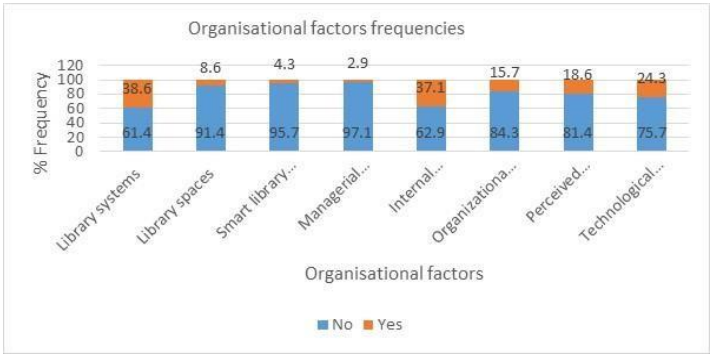

Figure 9: *Organizational Factors*

Environmental Factors

This section seeks to answer the following research question:

"*What are the environmental factors influencing smart libraries among universities?*"

Results consisting of 30 frequency counts that are related to environmental factors affecting the adoption of smart library adoption at universities are presented. As shown in Figure 10, the results of the frequency count related to the organizational factors found in the articles published between 2013 and 2018 indicate that only 8.6% of the articles mentioned legislation and regulations as a factor influencing the adoption of smart library at universities. About 18.6% of the articles mentioned industry characteristics and market structure as a potential influencing factor. Each of the remaining four environmental factors were recorded in only 2.9% in the articles. The environmental factors thus reflect the lowest frequencies.

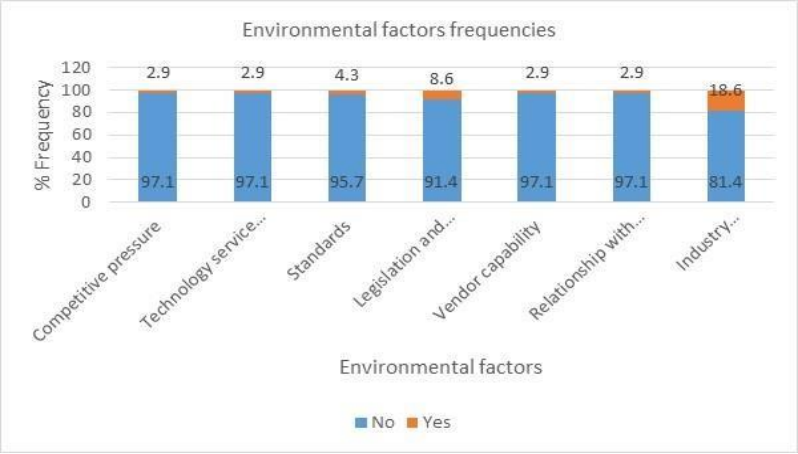

Figure 10: Environmental Factors

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DISCUSSION AND CONCLUSION

The results from the study indicate that the number of studies on smart libraries has increased significantly during the period 2015 to 2018. Although a significant decrease in the number of studies was observed in 2017, the concept of a smart library is still a trend in publications. In addition, the results suggest that Asia (31 articles) has done more research on smart libraries and is therefore perceived as the predominant region on the topic. India and China are leading countries in Asia in the research on smart library. This might be because those countries are technologically more advanced or their proposed systems that have been designed for future smart library designs in those regions. The results suggest that the qualitative method is the most frequently used approach for studying smart library adoption at universities. In light of these results, it is rather concerning that the multi-method approach has been less frequently used. This, however, is raising the need for researchers to adopt the multi-method approach, as it can be beneficial for studying smart library adoption among universities.

The overall frequency count of the environmental factors was the lowest (30); this suggests that very few studies have been conducted on the environmental factors that influence the adoption of smart library among universities. The results suggested that industry and market characteristics are perceived as an important factor regarding environmental factors. The industry and market characteristic construct did not show any significant difference between the published articles per year. Therefore, the constructs appear across all years from 2013 and 2018. Furthermore, none of the environmental factors showed a significant difference across the variances based on the years, this suggested that although the frequencies were low, the constructs appeared across all years of the study. Legislation and regulation construct showed a significant difference in the research methodology used thus suggesting that some methodologies used in the study did not mention legislation and regulation. However, this does not rule out the importance of legislation regulation suggested by the literature, and innovation in information and communication policy and regulation needs to be considered. Although the frequency count is at its lowest for environmental factors, its importance should not to be overlooked.

Although the literature search does not support the results significantly, it may simply be due to little research that existed in this area. Due to the nature of libraries, it has been perceived as an aid in academic studies and research and not so much as a commercial entity. Evaluating the environmental factors may add value to the future of smart libraries as this will aid researchers in utilizing smart libraries effectively and thus improving the research process. Universities and society benefit directly from the end results of the output produced by researchers. Evidently, this will give a competitive edge to universities to produce the most quality research. The variable competition did not show a significant difference across the years of publication. This indicates that it has been discussed across all years. Although the results indicate a low-frequency count, it has been supported by a few authors in the literature search. Presumably, although little research existed pertaining to competition, valuable research has been conducted by the authors who undertook the studies.

The total frequency count for organisational factors was 105. This construct is the second highest amongst the 3 constructs (TOE constructs). The results from the study showed that internal perceived technological competence is viewed as important as an organisational factor. In addition, the internal perceived technological competence did not show a significant difference between the published articles in the study. Furthermore, library systems as a resource revealed an importance in the results. The library systems construct did not display a significant difference that proposes that there is agreement among regions on its importance in library systems as a resource of smart library. The literature, however, suggested that smart library systems should be integrated with data analytics to improve its efficiency among library systems. In addition, the results suggested that technological readiness is a variable in the adoption of smart library among universities. The literature suggested that technological readiness is an important factor in adopting smart library because several spheres of societies are affected by it. Libraries need to evaluate the extent they are willing to take toward the fourth industrial revolution and evaluate the capacity of their technological readiness. The literature

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search pertaining to smart library systems was mostly identified. Several authors had identified futuristic smart library systems. Amongst all the factors, it is the most valuable factor to be considered in light of viewing both the results and literature search.

The results from the study show that the technological factors were the highest based on the frequency count. The literature supports the perceived usefulness of technologies applicable to smart libraries through the various technologies explained. Furthermore, in particular, the literature suggested that cloud computing is perceived useful in the adoption of smart library among universities. The results also suggest that ease of use is an important factor to consider in the adoption of smart library. Furthermore, the study suggests that perceived benefits is important. The literature support the results of technological factors; more precisely, the technologies applicable to smart libraries adoption across all years of publications. The TOE framework was the best fit for this study as its focuses on several aspects pertaining to smart library adoption.

This study explored the factors that influence the adoption of smart library adoption. The study was aimed at filling the gap between already published articles about smart library and the factors that influence its adoption. As part of the exploratory study, this research identified several factors that influence the adoption of smart library amongst universities, hence it contributes to the research area. This paper also acts as a stimulus to study the environmental factors influencing the adoption of smart library among universities due to the low-frequency count. The study made use of convenience sampling, this posed as a limitation because it causes difficulty in generalizing results. In addition, reliability concerns because of manual coding of the qualitative data even though reliability checks and coding rules were used; they are mostly subjective and dependent on the coder's analysis and knowledge. In addition, some articles were not easily accessible due to restriction permission to download the articles. Regardless of the limitation of the study, the study provides an opportunity for further research into the factors that influence the adoption of smart libraries. Further research may consider empirical study as opposed to secondary data.

REFERENCES

Aleisa, N. & Renaud, K. (2016). Privacy of the Internet of Things: A Systematic Literature Review (Extended Discussion). 5947–5956. DOI: 10.24251/HICSS.2017.717.

Atif, Y., Mathew, S.S. & Lakas, A. (2015). Building a smart campus to support ubiquitous learning. *Journal of Ambient Intelligence and Humanized Computing. 6(2):223–238.* DOI: 10.1007/s12652-014-0226-y.

Babbie, E., Mouton, J., Vorster, P. & Prozesky, B., (2001). The practice of social research. Cape Town: Oxford University Press Southern Africa (Pty) Ltd.

Bansode, H.C., Mhatre, S.M., Patil, A.N., Talkar, G.C. & Yadav, P.K. (2016). Smart Library Using NFC. 5(5):1688–1690.

Baryshev, R.A., Babina, O.I., Zakharov, P.A. Kazantseva, V.P. & Pikov, N.O. (20150. Electronic Library : Genesis , Trends . From Electronic Library to Smart Library. 6(2015 8):1043–1051.

Ben Ahmed, K., Bouhorma, M. & Ben Ahmed, M. (2014). Age of Big Data and Smart Cities: Privacy Trade-Off. International. *Journal of Engineering Trends and Technology. 16(6):298–304.* DOI: 10.14445/22315381/IJETT-V16P258.

Dörnyei, Z. (2007). Research methods in applied linguistics. New York: Oxford University Press.

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.*

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Fernandez, P. (2016) Through the looking glass: envisioning new library technologies" how artificial intelligence will impact libraries", *Library Hi Tech News, 33(5):5-8,* https://doi.org/10.1108/LHTN-05-2016-0024.

Fink, G. A., Zarzhitsky, D.V.,Carroll, T.E, & Farquhar, E.D. (2015) Security and privacy grand challenges for the Internet of Things. *International Conference on Collaboration Technologies and Systems (CTS), Georgia, 2015*.

Gangwar, H., Date, H. & Raoot, A.D. (2014). Review on IT adoption: insights from recent technologies. *Journal of Enterprise Information Management.* 27(4):488–502. DOI: 10.1108/JEIM-08-2012-0047.

Giannakos, M.N., Sampson, D.G. & Kidziński, Ł. (2016). Introduction to Smart Learning Analytics: Foundations and Developments in video-based learning. Smart Learning Environments. 3(1):12. DOI: 10.1186/s40561-016-0034-2.

Gressel, M. (2014). Are Libraries Doing Enough to Safeguard Their Patrons' Digital Privacy? *Serials Librarian*. 67(2):137–142. DOI: 10.1080/0361526X.2014.939324.

Haggarty, L. (1996). *What is content analysis?* Medical Teacher, 18:2, 99-101, DOI: 10.3109/01421599609034141

Hayikader, S., Toriq, M., Niyaz, M. & Dahlan, A. (2015). Big Data and a Smarter University : A Literature Review. *International Journal of Scientific and Research Publications,* Volume 5, Issue 5, May 2015 1 ISSN 2250-3153 5(5):1–4.

Hoy, M.B. (2016). Smart Buildings: An Introduction to the Library of the Future. *Medical Reference Services Quarterly*. 35(3):326–331. DOI: 10.1080/02763869.2016.1189787.

Kempton, L., Goddard, J., Edwards, J., Hegyi, F.B. & Elena-Pérez, S. (2013). Universities and Smart Specialisation. European Commission. (03). DOI: 10.2791/52851.

Jadhev, C.J., Jadhav, S.S., Sancheti, V.M & Hajare, S.S. (2017). Smart Library Management System Using RFID Technology*. International Research Journal Engineering and Technology*. 04(05).

Jeong, J-S., Kim, M. & Yoo, K-h. (2013). A Content Oriented Smart Education System based on Cloud Computing. *International Journal of Multimedia and Ubiquitous Engineering*. 8(6): 313-328.

Jokonya, O. (2015). Investigating Open Source Software Benefits in Public Sector. *48th Hawaii International Conference on System Sciences*.

Khuntia, S.K., Mishra, M & Ramesh,D.B .(2016). Applicability of information technology in libraries with a step ahead to smart library in 21st century *.Indian Journal of Library Science and Information Technology, January-June, 2016;1(1):22-25*

Leedy, P. D. (1993). Practical research: Planning and design. New Jersey: Prentice-Hall.

Lopes, I.M. & Oliveira, P. (2017). Can a small city be considered a smart city? Procedia Computer Science. 121:617–624. DOI: 10.1016/j.procs.2017.11.081.

Mouton, J. (1996). *Understanding Social Research*. First edition ed. Pretoria: J.L van Schaik publishers.

Nag, A & Nikam, K. (2016). *Internet of Things Applications in Academic Libraries. International Journal of Information Technology and Library Science*. ISSN 2349-235X. 5(1):1-7

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Nkhoma, M & Dang, D. 2013. Contributing Factors of Cloud Computing Adoption: a Technology-Organisation-Environment Framework Approach*. International Journal of Information Systems and Engineering (IJISE)*.1 (1):38-49.

Oliveira, T. and Martins, M, F. (2011) "Literature Review of Information Technology Adoption Models at Firm Level" *The Electronic Journal Information Systems Evaluation Volume Management research 14 Issue 1 2011, (pp110- 121),*

Rose, S., Spinks, N. & Canhoto, A.I., (2014). *Management Research*: Applying the principles. Routledge.

Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research Methods for Business Students*. Pearson Education Limited. 5th edition: 445

Simović, A. (2018). A Big Data smart library recommender system for an educational institution. Library Hi Tech Vol. 36 No. 3, 2018 pp. 498-523,DOI 10.1108/LHT-06-2017-0131

Wasike, J.M & Njoroge, L. (2015). Opening libraries to cloud computing: A Kenyan perspective. *Library Hi Tech News*. 32(3):21–24. DOI: 10.1108/LHTN-09-2014-0072.

Yao, F., Zhang, C. & Chen, W. (2015). Smart talking robot Xiaotu: participatory library service based on artificial intelligence. Library Hi Tech. 33(2):245–260. DOI: 10.1108/LHT-02-2015-0010.

Yuvaraj, M. (2015). Problems and prospects of implementing cloud computing in university libraries: A case study of Banaras Hindu University library system, Library Review. 64 (8/9): 567-582. https://doi.org/10.1108/LR-01-2015-0007.

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INVESTIGATING FACTORS AFFECTING THE ADOPTION OF SMART CLASSROOMS IN UNIVERSITIES

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**Corresponding author*

ABSTRACT

Aim/Purpose	The aim of the study was to explore the factors that affect the adoption of smart classrooms at universities.
Background	Studies that are focussed on factors that influence the adoption of smart classrooms at universities are limited. A deeper understanding of these factors is therefore to facilitate the successful adoption of the smart classrooms at universities.
Methodology	The systematic literature review methodology was used to determine the factors influencing the adoption of smart libraries at universities. The research study adopted the Technological, Organizational and Environmental (TOE) framework to provide a holistic view pertaining to factors that influence the adoption of smart classrooms at universities. Furthermore, content analysis was adopted in this research study to analyse work published between 2013 and 2018 on the adoption of smart classrooms at universities.
Contribution	This research paper contributes to the limited body of knowledge on factors that influence the adoption of smart classrooms at universities. Specifically, an attempt will be made to close the existing gap relating to the underlying factors behind the adoption of smart classrooms at universities.
Findings	Results emanating from this research study suggest that the technological factors are the most impactful factors in respect of the adoption of the smart libraries at universities. In addition, cloud computing is perceived to play a critical role in the adoption of smart classrooms at universities.
Recommendations for Practitioners	From the practitioner perspective, it is recommended that due consideration be given to the TOE Framework since it is very useful for assisting Practitioners to gain a better understanding of the underlying factors influencing the adoption of smart classrooms at universities.
Recommendations for Researchers	It is recommended that researchers should put more emphasis on using empirical studies; unfortunately, the current study is limited since it was based on secondary data. The adoption of different research methodologies may also prove to be important for future research.
Impact on Society	The study will be of benefit to the universities intending to adopt smart classrooms. The study will be used to check readiness levels of universities before making a decision to adopt smart classrooms.
Future Research	Future research should focus on the collection and analysis of the relevant empirical data as well as the development of different frameworks to gain a deeper understanding of the factors affecting the adoption of smart classrooms at universities.

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Keywords Smart universities; Smart classrooms; Technological factors; Organizational factors; Environmental factors.

INTRODUCTION

NA smart university is a learning environment that comprises several smart solutions such as smart parking, library, classroom and others. Smart classrooms, which is the subject of this research study, have transformed several universities into a technology-supported environments that reinforces performance and success. According to Li, Kong & Chen (2015), a smart classroom is an open learning environment that brings the students to an authentic learning context. It provides a teaching system that facilitates the interaction between the teacher and the learner, and offers a distinguished environment that improves the learning experience of students. Furthermore, smart classrooms often consist of the following components that facilitate the teaching and learning process: classroom management system; interactive smart boards; audios and video elements; multimedia control centre; and computers. The adoption of smart classrooms at universities can be very beneficial to both the students and educators. However, some universities are still unable to successfully adopt smart classrooms because of the various technological, organizational and environmental factors that affect this adoption. For instance, the integration of an effective smart classroom comprises several technological tools that are often very complex. Al-Hunaiyyan, Al-Sharhan & Alhajri (2017) have noted that "incorporating many pedagogical and technological elements become a new dimension of complexity". To address complexity challenges, universities should have a deeper understanding of the various factors that affect the adoption of smart classrooms in order to devise new ways to increase this adoption. Therefore, this research study is aimed at providing a deeper understanding of the factors that slow down the realization of smart classrooms at universities. More precisely, the research study will identify the technological, organizational, and environmental factors that limit the adoption of smart classrooms at universities. To this end, the exploratory research question is: What are the factors affecting the adoption of smart classrooms at universities?

LITERATURE REVIEW

The adoption of smart solutions at universities has improved the quality of lives of students and educators by enhancing their performances. According to Bakken, Uskov, Penumatsa and Doddapaneni (2017), "all universities should become smarter in order to optimize learning". A smart university is a university that uses technologies that can increase the productivity of knowledge management (Hayikader, Khan & Dahlan, 2015). In addition, smart universities are a result of the integration of technologies such as big data, internet of things, cloud computing and others. Research conducted by Sari, Ciptadi & Hardyanto (2017) described the use of internet of things (IoT) in the development of smart universities. IoT often consists of various information processing equipment and information sensing identification devices such as Radio Frequency Identification technology (RFID), Global Positioning System (GPS), and others. These devices ensure that the various domains of smart universities (e.g., smart classrooms, smart parking, smart buildings) are automatically monitored and controlled. For example, the use of RFID sensors in smart rooms provides information about the number of students present in the room and the vacant room. Rahman, Abbasi & Shaikh (2008) add that RFID provides a means to automate electrical appliances, track employees and record their attendance. Smart universities often comprise different smart solutions such as smart

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parking, smart classroom, smart library, and smart buildings. This is study is therefore focussed on smart classrooms at universities.

SMART CLASSROOMS

The concept of a smart classroom has been around since new forms of media technology was being used for instructional purposes (Bogart & Wichadee, 2016). According to Bakken et al. (2017), a smart classroom "is an intelligent classroom for teachers involved in distant education that enables teachers to use a real classroom type teaching approach to teach classroom-based and distant students". Although a smart classroom can be a very complex innovation for the educational sectors, it has many benefits. A smart classroom offers a distinguished environment that improves the learning experience of students. Li, Kong & Chen (2015) define a smart classroom as "an open learning environment to bring the students to an authentic learning context". It can stimulate students' learning motivation, engage students' creation, and it gives students hands-on learning experience effectively.

Furthermore, smart classrooms often consist of components such as; classroom management system, interactive smart boards, audios and video elements, multimedia control centre and computers. According to Al-Sharhan (2015), these components "form an interactive and interesting learning environment that enrich the teaching methods and develop the students' skills and raise their academic level and allow them to participate more in the learning process". Moreover, Das (2016) suggests several principles that must be considered for a normal classroom to be transformed into a smart classroom. These principles include safety, comfort, adaptability, flexibility, connectivity and multiplicity. As far as Das (2016) is concerned, "Smart classroom with heavy technological integration requires a high degree of security". Hence, a smart classroom must have several arrangements that ensure safe access to information and prevent users from any form of physical accidents.

BENEFITS OF SMART CLASSROOMS

Technology has brought enormous changes to both students and teachers. The use of smart equipment such as sensors, cameras, and microphone in smart classrooms allow students to gain a better understanding and acquire knowledge quicker. In addition, the management of the classroom becomes much easier and simpler. The good thing about smart classrooms is that they allow teachers to see how students actually want to learn and give the knowledge to students on the way students want it (Simie et al., 2015). This way, the smart classroom has become very beneficial to both teachers and students. Furthermore, a smart board that is often considered as the key feature of a smart classroom has several benefits. To begin with, one of the most important advantages of a smart board is its interactivity. According to Preston & Mowbray (2008), "The SMART Board provides teachers and students with a whole new interactive learning environment to share ideas, information, images, animations, audio or video". This technology enables teachers to reinforce content thus making lessons enjoyable for students.

SMART CLASSROOM TECHNOLOGIES

Internet of Things (IoT)

An effective smart classroom is a result of the integration of Internet of things. The smart technology has the potential of connecting things to the internet for an easier exchange of information. Temkar, Gupte & Kalgaonkar (2016) has mentioned the importance of internet of things (IoT) in developing a smart classroom. The integration of the Internet of things can transform a standard classroom into a smart classroom that listens and analyses behaviours,

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discussions and voices. This enables educators to deliver quality presentations thus allowing students to benefit from pleasant and entertaining lectures. Furthermore, EL Mrabet & Ait Moussa (2017) advocates the necessity of integrating Internet of things in smart classrooms. The integration of Internet of things in smart classrooms facilitates communication between people (lecturers and learners) and objects such as Near-field communication (NFC), and Wireless sensor network (WSN). According to EL Mrabet & Ait Moussa (2017), proper communication often enhances the lecturing and learning process. In addition, a study conducted by Gul, Yasir & Majid (2017) has pointed out the advantage of using IoT for management of smart classrooms. This technology enables teachers to easily manage and control their classrooms.

Augmented and Virtual Reality

Augmented reality (AR) and virtual reality (VR) are vital technologies for the development of a smart classroom. AR and VR have the potential to enhance the understanding and performance of students in the most complex and experimental concepts. Chauhary & Anuradha (2013) have highlighted the importance of virtual and augmented reality in smart classrooms. These technologies encourage students to participate and interact during lessons. For instance, the use of collaborative virtual reality uses text with virtual worlds which create a social atmosphere and encourages collaboration. According to Chauhary & Anuradha (2013), Augmented and virtual reality "…allows the disabled to participate in an experiment or learning environment, and it transcends all language barriers".

Radio Frequency Identification Technology (RFID)

The utilization of RFID in smart classrooms has resolved several issues especially the lack of student's attendance. According to Akpinar & Kaptan (2010), "RFID is a term that is used to describe a system that transmits the identity of an object or person in the form of a unique serial number, using radio waves". Mehta et al. (2015) has drawn attention to the importance of using RFID technology in smart classrooms. Some educational sectors still lack the use of an effective method to collect the actual attendance of students at the end of each class to combat fake attendances. However, the introduction of RFID in smart classrooms has the potential to reduce the chronic rate of absenteeism. For instance, an RFID ID student card could be used to track the attendance of students. This facilitates the roll-call system that reads each student ID individually and confirms the number of attendance.

THEORETICAL FRAMEWORK

TOE framework is an analytical technique that was developed by Tornatzky & Fleischer (1990). This framework is frequently considered for studying the adoption of innovations in organizations. According to Ismail & Makhtar (2016), "The TOE framework recognises three aspects of a firm's contexts that stimulates the adoption and implementation of a technological innovation". These aspects include technological, organizational and environmental contexts (see Table 1). The technological context considers the available technologies important to the firm, both Internal and external, that might be useful in improving organizational productivity (Lippert & Govindarajulu, 2006). This often includes security, complexity, availability consistency, compatibility and network bandwidth. Furthermore, the organizational context describes the available characteristics that support or discourage the acceptance of technological innovations. These characteristics often include fear of failure, support, cost, employee skills and firm size. In addition, the environmental context includes all the external

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attributes to the firm such as external pressure, customer demand, competition and government rules and regulations.

Table 1: Predefined TOE Variables

Technological factors	Organizational factors	Environmental factors
Security	Employee skills	Competition
Complexity	Fear of failure	External pressure
Compatibility	Cost	Customer demand
Network bandwidth	Support	Government rules
Relative advantage	Infrastructure	Support
Availability	Management	

RELATED STUDIES

Several studies have been conducted on smart classrooms using other models and frameworks such as Diffusion of Innovation Theory and Technology Acceptance Model (TAM). For instance, research conducted by Alenazy (2017) on smart classrooms made use of the TAM. This model was used to increase the motivation level and ability of students and teacher to operate efficiently in any smart classroom.

RESEARCH DESIGN AND METHODOLOGY

This section discuss the methodology used to address the research questions and the objectives of the study. Research is a logical and systematic search for new and useful information on a particular topic (Rajasekar, Philominathan & Chinnathambi, 2006). It generally follows a research method and design to attain its objectives. Research design can be considered as the structure of research; it is the "Glue" that holds all of the elements in a research project together and is in short a plan of the proposed research work (Akhtar, 2016). To study the factors that affect the adoption of smart classrooms at universities, a systematic literature review was conducted. According to Kitchenham & Charters (2007), this approach is "a form of secondary study that uses a well- defined methodology to identify, analyse and interpret all available evidence related to a specific research question in a way that is unbiased". In addition, Bruce & Mollison (2004) have remarked that "a systematic review is a critical synthesis of research evidence, which involves analysis of all available and relevant evidence in a systematic, objective and robust manner".

Hence, the primary reason for undertaking this approach was to identify various gaps and themes in this study to propose an area for further investigations. Moreover, the research question of the study is considered as being descriptive in nature because it focused on describing the various factors that affect the adoption of smart classrooms at universities. Furthermore, to analyse the data of the study a content analysis approach was used. According to Rose, Spinks & Canhoto (2015), content analysis can be seen "as a bridge between qualitative and quantitative analyses". In this study, all the qualitative data was converted to quantitative data via coding in order to generate frequencies using the Statistical Package for the Social Sciences (SPSS). Therefore, this study is a descriptive quantitative research that focuses on identifying the various factors that affect the adoption of smart classrooms at universities. The identified problem for this study focuses on the limited adoption of smart classrooms at universities. The primary question seeks to identify the various factors that affect adoption. Based on this, the unit of analysis is universities.

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INSTRUMENT DEVELOPMENT

A criteria guideline was designed for the selection of articles in order to identify the main study that provided evidence about the research question. The data was collected based on the following criteria: the year of publication; Research method and type; Region; framework; and the variables. In addition, the study made use of predefined TOE variables identified from the article of Baker (2010) in order to collect data from 70 articles. These variables were classified into three main categories, namely: technological, organisational and environmental factors (see Table 1). Furthermore, a matrix was then constructed on an Excel Spreadsheet using these variables; whenever a variable was found in an article, it was marked as "1" and when a variable was not found it was marked as "0" (Refer to Appendix A). Thereafter, the frequencies of these variables were compared so as to identify the dominant factors. Lastly, the collected data was coded and a quantitative analysis of the data was carried out using of the SPSS program. This program has proven to be important in the generation of the frequencies of the variables, analysis of variance and correlations.

DATA SOURCE

Data is an important aspect of research because every research consists of analysis and interpretation of data to extract information. The data of a study can be collected either from a primary or secondary data. In this research study, the data was collected from secondary data that was acquired from five popular databases, namely: Google Scholar, Research Gate, Springer, Science Direct, and Emerald Journals. In addition, the type of articles that were collected were peer-reviewed journal articles and conference papers that were published in English. These articles were collected for the period 2013 to 2018.

RESEARCH METHOD

Research methods are the various procedures, schemes and algorithms used in research (Rajasekar et al., 2006). These methods enable researchers to collect data and find a solution to the researchers' problems. For purposes of this study, a systematic literature review was conducted to identify the various factors affecting the adoption of smart classrooms at universities. According to Haase, Pigosso & McAloone (2017), "this type of literature review follows a strict methodology to enable replicability". Therefore, this study followed the three review process proposed by Kitchenham (2007). The process was consisted of planning, conducting and reporting. In the first phase, five steps were followed to plan for the proper systematic literature review. These steps included:

- **Objective definition**: The objective of this research is to identify the factors affecting the adoption of smart classrooms at universities.
- **Database definition**: The data of the study was collected from five main databases, namely: Google Scholar, Research Gate, Springer, Science Direct and Emerald Journals.
- **String definition**: Keywords relevant to smart classrooms were selected in the searching process. These included terms such as: "smart classrooms" OR "Intelligent classrooms" OR "Clever classrooms" OR "e-classrooms".
- **Inclusion criteria**: To obtain relevant results, the following inclusion criteria were used: Relevance to the topic - all articles were related to the topic; Peer-reviewed - all articles were peer-reviewed; Year - all articles were published during the period 2013 to 2018; Language - all articles were published in English.
- **Searching:** Throughout the search, "Smart classrooms" and "Smart Universities" were the important keywords that gave the greatest number of results. Hence, they were

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applied in all the databases mentioned above as a way of getting quick and relevant results.

- The **conducting** step consisted of performing searches in the various search engines, assessing the obtained articles using the predefined criteria (Inclusion) and extracting relevant data from selected articles.
- The final **reporting** stage consisted of analyzing and reporting the results obtained. Therefore, in this case, after analyzing the data collected from the 70 articles using the SPSS software, the output obtained was discussed in the results section with the aid of tables and diagrams

DATA ANALYSIS

Based on the research method adopted for the research study, a content analysis approach was used to analyze published articles on the adoption of smart classrooms at universities. According to Williams (2007), "Content analysis review forms of human communication including books, newspapers, and films as well as other forms in order to identify patterns, themes, or biases". A content analysis can be either qualitative or quantitative. A quantitative content analysis approach was employed for this research study. According to Boettger & Palmer (2010), in this context "Content analysts evaluate texts for predefined terms and phrases and use inferential statistics to make conclusion about their presence". In addition, since this research study had to make use of a huge amount of data to generate frequencies, a quantitative content analysis was found to be suitable for this study.

RESEARCH RESULTS

This section present and discusses the various results from the conducted analyses of the 70 articles published between 2013 and 2018. The first section discussion the demographic results of the analysis. The last sub-sections presents and discuss various TOE factors.

DEMOGRAPHIC CHARACTERISTICS

This section presents the demographic results of the collected articles. These variables included the Year of publication, Research Method and Type, Region and Framework.

Year of Publication

The figure below illustrates the result of the frequency of the articles published between 2013 and 2018. The results show that the year 2013 had the greatest number of publications (26%). 18 articles collected were published in this year. On the other hand, results show that the year 2018 had the lowest number of publications (3%). Only 3% articles collected were published in 2018. The results show that there were an increase in pattern on the number of published articles from year 2013 to 2016. Lastly, the results suggest that there was a significant decreased on the number of published articles from the year 2016 to 2018.

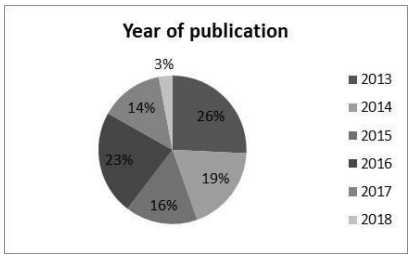

Figure 1: Distribution of collected articles according to year of publication

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Research Method Used

The results of the type of research methods used in the articles published from 2013 to 2018 are presented in Figure 2. Whereas most of the article published (17; 24%) made use of the qualitative research methodology, only 14 (20%) of the published articles employed quantitative methods. At (6%), very few researchers (4 articles) used the mixed (i.e., qualitative and quantitative) research method. The study suggest that there was low usage of mixed research methods of the published articles.

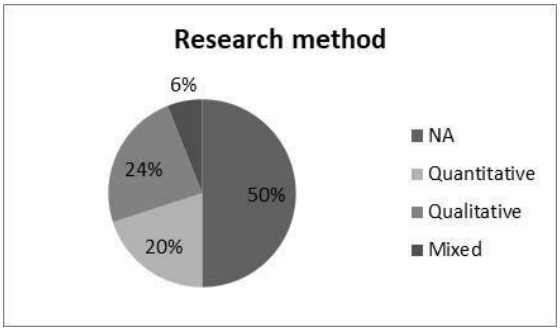

Figure 2: Distribution of collected articles according to research method

Research Type

The 70 articles made use of different methods to collect data. The figure below illustrates the result of the research type used in the articles published from 2013 to 2018. Results show that 23 published articles used survey as their research type. The frequency shows that this research type had the greatest percentage (33%). Also, 4 articles made use of Case study (6%). In addition, two articles collected made use of experiments (2%). Lastly, the frequency shows that systematic literature review has the least percentage (1%)

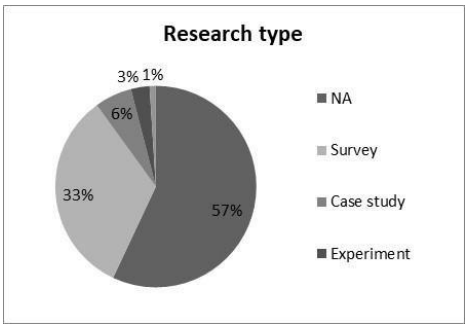

Figure 3: Distribution of collected articles according to type of research

Region of Publication

The distribution of the collected articles by region for the period of investigation is illustrated in Figure 4. The highest number of articles were published in Asia (51; 73%). This was followed by North America with 11 articles (15%). The results from the frequency show that only 6% of the articles were published in Africa and also 6% published in Europe. Therefore, results show that most of the articles on smart classrooms were published in Asia.

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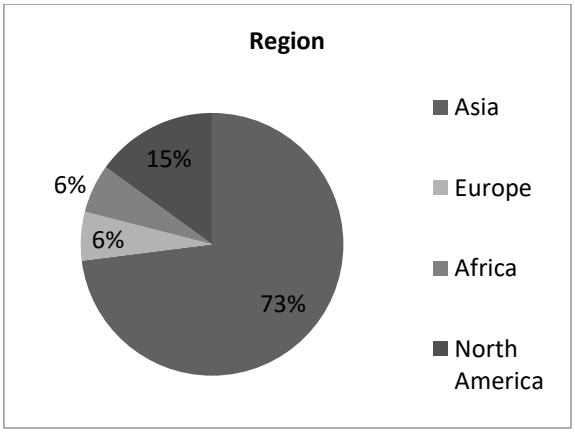

Figure 4: Distribution of collected articles according to region

TOE Factors

This section presents the results of the technological, organizational and environmental factors affecting the adoption of smart classrooms in universities.

Technological Factors

The study assessed the various technological factors that affect the adoption of smart classrooms in universities. These factors included; security, complexity, compatibility, network bandwidth, relative advantage and availability. Figure 5 shows the technological factors that affect the adoption of smart classrooms in universities based on the 70 articles. Results show that only 33 articles (47%) mentioned security as a factor that affects the adoption of smart classrooms in universities. Furthermore, 45 articles with a percentage of 64 mentioned complexity as a factor that affects the adoption of smart classrooms in universities. Moreover, 23 articles (33%) mentioned compatibility as a factor affecting the adoption of smart classrooms. About 25 articles (36%) noted network bandwidth as a factor affecting the adoption of smart classrooms. Further, availability appeared in 20% of the articles. In addition, the majority of articles (64) mentioned relative advantage as an important factor that influences the adoption of smart classrooms in universities. Therefore, results reveal that relative advantage had the highest number of frequencies and availability the least number of frequencies. In addition, according to results complexity and relative advantage were the only technological factors that had frequencies above fifty percent.

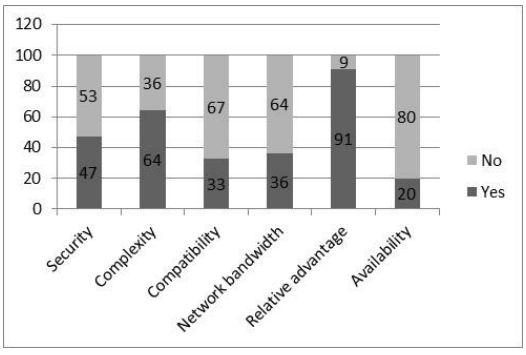

Figure 5: Technological factors

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Organizational Factors

Figure 6 shows the technological factors affecting the adoption of smart classrooms in universities based on the 70 articles. These factors included; employee skills, fear of change, cost, support, infrastructure, firm size and management. Results show that only 22 articles (31%) mentioned employee skills as a factor that affects the adoption of smart classrooms in universities. Furthermore, 24 articles with a percentage of 34 mentioned the fear of change as a factor that affects the adoption of smart classrooms in universities. In addition, cost appeared in the majority of articles (40) with the percentage of 57 as a concern in the adoption of smart classrooms in universities. Further, 17 articles (24%) mentioned support as a technological factor that affects the adoption of smart classrooms. About 15 (21%) articles noted infrastructure. Moreover, firm size was the least mentioned as a factor influencing the adoption of smart classrooms with a percentage of 6. Lastly, management appeared in 13% of the articles. Therefore, results reveal that cost had the highest number of frequencies and was the only organizational factor with a frequency above fifty percent.

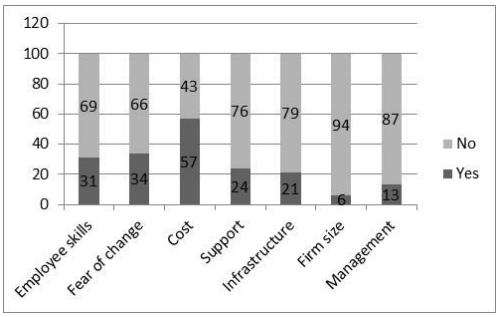

Figure 6: organizational Factors

Environmental Factors

This study assessed the various environmental factors that affect the adoption of smart classrooms in universities. These factors included; Competition, external pressure, customer demand, government rules and regulations and support. Figure 7 shows the environmental factors affecting the adoption of smart classrooms in universities based on the 70 articles. Results show that only 16% of the articles mentioned competition as a factor that affects the adoption of smart classrooms in universities. Furthermore, 10% of the published articles mentioned external pressure as a factor influencing the adoption of smart classrooms in universities. Moreover, 13% mentioned customer demand as a factor affecting the adoption of smart classrooms. In addition, government rules and regulation was the least factor mentioned in articles with 7%. Lastly, 23% of the articles mentioned support as a factor affecting the adoption of smart classrooms in universities. Therefore, results reveal that support was the most common in the published articles and that none of the environmental factors had a frequency of more than fifty percent.

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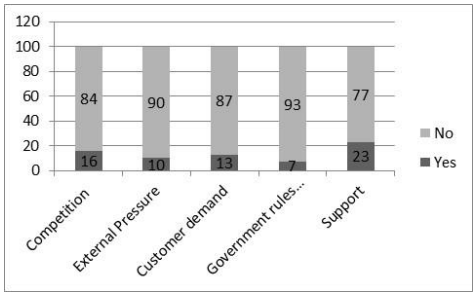

Figure 7: Environmental Factors

Technologies

The study assessed some technologies used in smart classrooms figure 8. Results show that 24% of the articles discussed the use of internet of things in smart classrooms. In addition, eight articles (11%) discussed the use of Radio Frequency Identification (RFID) in smart classrooms. Moreover, both cloud computing and virtual reality/augmented reality appeared in 6% of the articles. Lastly, big data was the least technology with 3%.

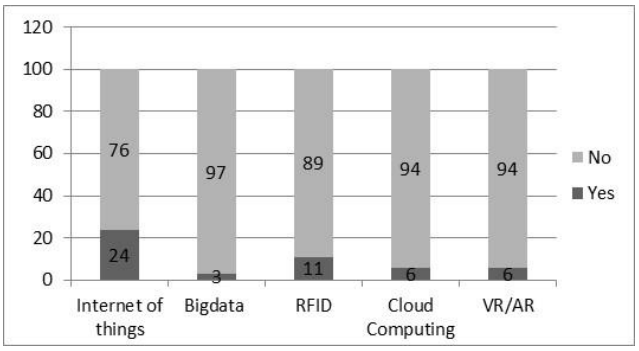

Figure 8: Technologies

DISCUSSION AND CONCLUSION

This study presents the results of a performed systematic literature review, which included 70 articles on the technological, organizational and environmental factors that often affect the adoption of smart classrooms in universities. Results from the analysis of these articles suggest an increase and a decrease in the number of studies on the adoption of smart classrooms from 2013 to 2018. In addition, there was a significant decreased interest in the topic from 2016 to 2018. The results reveal that most of the reviewed articles on the adoption of smart classrooms made use of a qualitative approach. However, very little studies made use of a mixed approach. Hence, researchers can take into consideration the use of this approach to study the adoption of smart classrooms in universities. In addition, experiments and systematic literature review were underrepresented meanwhile survey was the mostly used research type on the articles reviewed by the study. Further, results suggest that the reviewed articles mostly were published in Asia meanwhile Africa and Europe had the least number of published articles. Diffusion of innovation theory seems to be the most common conceptual framework used in the reviewed articles.

Moreover, the study shows that technological factors are mostly influencing the adoption of smart classrooms in universities. Results suggest complexity and relative advantage were the

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most common in the articles reviewed by this study. The results support the literature in that the incorporation of many technological elements is a new dimension of complexity (Al-Hunaiyyan et al. 2017). Furthermore, cost was the most common organizational factor that appeared on the reviewed published articles. The results support the idea of in that cost is a strong inhibiting organizational factor in the adoption of technology in classrooms (Firmin and Genesi, 2013).

Similarly, the growing popularity of the adoption of smart classrooms and the lack of deeper understanding of the environmental factors that affect this adoption implies a need for further research. Moreover, the underrepresentation of mixed research method in articles reinforces the need for further research. The limitation of the study is that it was based on systematic literature review not empirical data. Hence, future studies should focus on empirical studies to investigate the factors that affect the adoption of smart classrooms in universities. Additionally, future researchers should make use of a systematic literature review to identify more gaps in this topic. To conclude, the study gave an overview of the various technological, organizational and environmental factors that affect the adoption of smart classrooms in universities. Even though this study was not exhaustive, it attempted to an extent to fill some gaps in the understanding of the various factors that affect the adoption of smart classrooms in universities hence contributing to the research area. In addition, the study lays a foundation for further studies because it presents several research gaps and opportunities.

REFERENCES

Al-Hunaiyyan, A., Al-Sharhan, S. & Alhajri, R. (2017). A New Mobile Learning Model in the Context of the Smart Classrooms Environment: A Holistic Approach. *International Journal of Interactive Mobile Technologies*, 11(3), p.39.

Al-Qirim, N. (2010). Determinants if interactive white board success in teaching in higher education institutions. *Computer & Education,* 56(2011), pp. 827-838.

Augusto, J. (2009). Ambient intelligence: opportunities and consequences of its use in smart Classroom. *Innovation in Teaching and Learning in Information and Computer Sciences*, 8(2), pp. 53-63.

Akhtar, I. (2016). Research Design. *Research in Social Science: Interdisciplinary Perspective*, pp. 68-84.

Akpinar, S. and Kaptan, H. (2010). Computer aided school administration system using RFID technology. *Procedia Social and Behavioral Sciences*, 2(2010), pp. 4392-4397.

Al-Sharhan, S. (2015). Smart Classrooms in the Context of Technology Enhanced Learning (TEL) Environment: A Holistic Approach. *Transforming Education in the Gulf Region – Emerging Learning technologies and Innovative Pedagogy for the 21st Century*, Taylor & Francis, London

Bakken, J. P., Uskov, V. L., Penumatsa, A. & Doddapaneni, A. (2017). Smart Universities and their Impact on Students with Disabilities. *EC Ophthalmology*, pp. 42-52.

Bogart, W. V. D. & Wichadee, S. (2016). Students' Perceived Effectiveness of Educational Technologies and Motivation in Smart Classroom. *TEM Journal. Volume 5, Issue 4,* Pages 566-574, ISSN 2217-8309, DOI: 10.18421/TEM54-22, November 2016.

Bruce, J. & Mallison, J. (2004). Reviewing the literature: adopting a systematic approach. *Journal of Family Planning and Reproductive Health Care*, 30(1), pp. 13-16.

Boettger, R. & Palmer, L. (2010). Quantitative Content Analysis: Its Use in Technical Communication. *Transaction on Professional Communication,* 54(3), pp. 346-357.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Chaudhary, D. and Amerada. (2013). A Proposed Model for Virtual Reality Based Smart Classes. *International Journal of Information and Computation Technology*, 3(5), pp. 439-444.

De, D. (2014). Sensor Network for Smart Environments. *Journal of Telecommunications System & Management,* 3(1), pp. 2.

Das, D. (2016). Modern Education with Smart Classroom. *RAY: International Journal of Multidisciplinary Studies*, 1(1), pp. 67-69.

EL Mrabet, H. & Ait Moussa, A. (2017). Smart Classroom Environment Via IoT in Basic and Secondary Education. *Transactions on Machine Learning and Artificial Intelligence*, 5(4).

Furdick, K., Lukac, G., Sabol, T. & Kostelnik. P. (2013). The Network Architecture Designed for an Adaptable IoTbased Smart Office Solution. *International Journal of Computer networks and Communications Security*, 1(6), pp. 216-224.

Firmin, M. W. & Genesi, D. W. (2013). History and Implementation of Classroom Technology. *Social and Behavioural Sciences,* 93(2013), pp. 1603-1617.

Gul, S., Asif, M., Ahmad, S., Yasir, M., Majid, M. & Malik. S. (2017). A Survey of Role of Internet of Things in Education. *International Journal of Computer Science and Network Security,* 17(5), pp. 159-165.

Hayikader, S., Khan, M. & Dahlan, A. (2015). Big Data and a Smarter University: A Literature Review. *International Journal of Scientific and Research Publication*, 5(5), pp. 1-4.

Hammed, M. & Counsell, S. (2012). Assessing the Influence of Environmental and CEO Characteristics for Adoption of Information Technology in Organisations. *Journal of Technology Management and innovation*, 7(1) pp. 65-84.

Haase, R., Pigosso, D. & McAloone, T. (2017). Product/Service-System Origins and Trajectories: A Systematic Literature Review of PSS Definitions and their Characteristics. *The 9th CIRP IPSS Conference,* 64(2017), pp. 157-162.

Heale, R. & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence Based Nursing*, 18(3), pp. 66-67.

Ismail, W. & Mokhtar, M. (2016). Application of the TOE Framework in Examining the Factors Influencing Pre- and Post Adoption of CAS in Malaysian SMEs. *International Journal of Information Technology and Business Management,* 49(1), pp. 26-37.

Jwaifell, M. & Gasaymeh, A. (2013). Using the Diffusion of Innovation Theory to Explain the Degree of English Teachers' Adoption of Interactive Whiteboards in the Modern Systems School in Jordan: A Case Study. Contemporary *Educational Technology,* 4(2), pp. 138-149.

Kitchenham, B. & Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering EBSE 2007-001. Keele University and Durham University Joint Report,

Lippert, S. & Govindarajulu, C. (2006). Technological, Organisational and Environmental Antecedents to Web Services Adoption. *Communications of the IIMA,* 6(1), pp. 147-160.

Li, B., Kong, s. & Chen, G. (2015). Development and Validation of the smart classroom inventory. *Smart Learning Environment*, 2(1).

Mehta, P. G., Jha, J., Zala, M. & Khetra, N. (2015). A survey on Various Technologies Available for Smart Lab based on Internet of Things. *International Journal for Scientific Research & Development*, 3(10), pp. 2321-0613.

Preston, C. & Mowbray, L. (2008). Use of Smart Boards for teaching, learning and assessment in Kindergarten Science. *Teaching Science,* 54(2), pp. 50-53.

Pishva, D. &Nishantha, G. (2008). Smart Classrooms for Distance Education and their Adoption to Multiple Classroom Architecture. *Journal of Networks*, 3(5).

Rose, S., Spinks, N. & Canhoto. A. (2015). Management Research: Applying the Principles London, Routledge. Pp. 1-9.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Rehman, A.U., Abbasi, A.Z. & Shaikh, Z.A. (2008). Building a Smart University Using RFID Technology. *2008 International Conference on Computer Science and Software Engineering*. Pp. 641-644.

Sari, M., Ciptadi, P. & Hardyanto, R. (2017). Study of Smart Campus Development Using Internet of Things Technology. *Computer Science and Informatics*, 190(2017), pp. 1-3.

Simie, K., Zrakie, M. D., Durie, I., Milie, A. & Bogdanovie, N. (2015). A Model of Smart Environment for e-learning Environment for e-Learning based on crowdsourcing. *Journal of Universal Excellence*, 4(1). pp. A1-A10.

Singh, S., Kumar, A. & Jain, K. (2015). Smart and Intelligent new generation classrooms over cloud. *Innovation and Technology in Education,* pp. 273-277.

Temkar, R., Gupte, M. & Kalgaonkar, S. (2016). Internet of Things for Smart Classrooms. *International Research Journal of Engineering and Technology*, 3(7), pp. 203-207.

Tanwar, K. & Gupta, S. (2014). Smart Class Using Li-Fi Technology. *International Journal of Engineering and Science (IJES)*, 3(7), pp. 16-18.

Tang, Z. (2017). On Study of Application of Big Data and Cloud Computing Technology in Smart Campus*. IOP Conference Series: Earth and Environmental Science*, 100, p.012026.

Tiwani, S. (2017). Improving Teaching-Learning through Smart Classes. *Suresh Gyan Vihar University Journal of Engineering & Technology*, 3(2), pp. 40-44.

Vimal, A., Albert, S. & Daisy, T. (2015). Internet of Things (IoT) based Smart Environment Integrating various Business Environment. *International Journal of Computer Application,* 128(8), pp. 32-36.

Williams, C. (2007). Research Methods. *Journal of Business & Economic Research*, 5(3), pp. 65-72.

Yas, Q. M., Khalaf, M. I., Mohammed, k. A. & Abdelouahab, A. (2010). Smart School and the effectiveness of interactive whiteboards, *In International Conference on Teaching and Learning Education*, pp.1-12.

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IMPLICATIONS OF PERCEIVED EASE OF USE, PERCEIVED RISK AND CULTURAL VALUES ON CITIZENS' ACCEPTANCE OF E-GOVERNMENT

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ABSTRACT

Aim/Purpose	The objective of the current research is to examine the potential implications as well as the need to include the perceived ease of use, perceived risk and cultural values on citizens' acceptance of e-government services.
Background	In South Africa, a thorough examination of the perceived ease of use, perceived risk and how the cultural dimensions influence the use of e-services remain under-researched and a concern in relation to citizens' acceptance of e-government services. In response to the concerns, the current research aims to systematically examine the impact of the perceived risks, the perceived ease of use, and the effects of cultural values on citizens' acceptance of e-government services.
Methodology	In response to the growing concerns, a systematic examination of the literature on citizens' acceptance of e-government services, with particular focus on the effects of the perceived ease of use, perceived risk and cultural values on citizens' acceptance of e-government services was employed.
Findings	The examination revealed an ongoing usage of different theories, methodologies and determinants. Despite this revelation, the examination is still inconclusive, even though crucial, as to how in South Africa, e-government is affected by the citizens' perceived ease of use and, perceived risk, nor is there research establishing how cultural dimensions affect acceptance of e-government services.
Future Research	Future research is still required to establish how the services offered through e-government are affected by the perceived ease of use and perceived risk in South Africa. There is also no research available as yet that has established how cultural dimensions impact citizens' acceptance of e-government services.

Keywords	Perceived ease of use; Perceived risk; Cultural dimensions; e-Government

INTRODUCTION

Similar to the term used in many other studies, e-government in the current study refers to governments' usage of information and communication technologies (ICT) in three folds. This being the provision of "…government information and public services to; citizens (G2C), businesses (G2B), and government employees (G2E) or other government organisations (G2G)" (Susanto, 2013; Zafiropoulos, Karavasilis & Vrana, 2012; Schaupp, Carter & Hobbs, 2010). Regardless of the form(s) of e-government services (G2C, G2B, G2E, and G2G), some persisting influencers include the perceived ease of use and the perceived risk of using such services. The perceived ease of use has been characterised as one's certainty associated with the use or application of an information system, which is free of effort or the use thereof is effortless (Zafiropoulos et al., 2012). On the other hand, perceived risk characterises the

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degree of uncertainty end-users associate with the information systems (Zafiropoulos et al., 2012).

However, the argument is that the effects of perceived ease of use, and perceived risk in combination with cultural dimensions on the adoption of e-government services in South Africa has not yet been thoroughly researched (Susanto, 2013; Zafiropoulos et al., 2012; Schaupp et al., 2010). The importance of this type of research lies in the fact that perceived ease of use and the perceived risk affect, to a great extent, citizens' acceptance level of e-government services, particularly considering their different cultural values (Susanto, 2013; Wangpipatwong, Chutimaskul, & Papasratorn, 2008; Dimitrova & Chen, 2006). The study is of great importance, as the past decade has witnessed a noteworthy increase of examination regarding e-government services in different forms (Ibrahim, Taib & Shahzad, 2016; Sarrayrih & Sriram, 2015; Yusuf-Dauda & Lee, 2015; Munyoka & Manzira, 2013; Suki & Ramayah, 2010; Wangpipatwong et al., 2008). As mentioned above, the studies have for the most part reported on the acceptance of e-government services in Malaysia (Suki & Ramayah, 2010), conjoint analysis of user preference for e-banking (Yusuf-Dauda & Lee, 2015), challenges associated with e-government (Sarrayrih & Sriram, 2015), the behavioural intention of Nigerians on e-government service (Ibrahim et al., 2015), and the analysis of citizens' continuance intent for using e-government services (Wangpipatwong et al., 2008).

Despite the growing need for studies on e-government services in South Africa, one major challenge, which has received little to no consistent attention is an examination of the perceived ease of use and the perceived risk for citizens combined with the cultural values affecting the end-users' acceptance of e-government services. Outside of South Africa, a comparative analysis of such behavioural constructs has already proven to be significantly important in the study of e-government services (Schaupp, 2010). Anchored upon a previous survey of about 300 taxpayers who were using electronic tax payments (e-tax) for instance, a conclusion reached was that "... reputation and perceived security control have a significant impact on risk perceptions" of e-filing and thus, e-government services (Schaupp, 2010). Ibid added that the perceived risk for citizens using the service has a significant impact on the intention to use an e-filing service.

Another dimension to consider is that regardless of the progress thus far and the increased use of designs such as survey design, some contestations that remain have been the inability to redirect attention towards a consideration of cultural and behavioural factors (United Nations e-Government Survey, 2014). Other constructs include, but are not exclusive to, monthly income, race, gender, age, the highest level of education, occupation in the form of a government employee, state enterprises employee, private sector employee, self-employment, unemployed, and retiree (United Nations e-Government Survey, 2014).

Thus, no exhaustive list may reasonably represent the review on the understanding [or lack thereof] of any e-government services theories. However, anchored upon the aim of the study, attention is restricted to examining the effects of: the perceived ease of use on citizens' acceptance of e-government service; the effects of the perceived risk; other influencers on citizens' acceptance of e-government services; and Hofstede's cultural theory and privacy calculus.

Given that there is little evidence in South Africa of an examination of the role of the three factors, coupled with an increasing demand for e-government services, the current research sought to analyse a hypothetical stance of the perceived ease of use, the perceived risk and the cultural constructs on citizens' acceptance of e-government services.

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RESEARCH OBJECTIVE

Given the contestations presented in the introductory section, the current research examined the effects of perceived ease of use, cultural values and the perceived risk on citizens' acceptance of e-government services.

Thus, the hypothetical position is that: perceived ease of use, perceived risk and cultural values significantly influence South Africans' acceptance of e-government services.

METHODOLOGY

The method was guided by a systematic review of both past and present literature via Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Kitchenham & Brereton, 2013; Enticott et al., 2017). The essence of PRISMA, as noted by Enticott et al. (2017), was to adhere to the standard operating procedure for conducting as well as reporting a systematic review. First, critical factors considered were the relevance and appropriateness of research related to perceived ease of use, perceived risk and cultural values on citizens' acceptance of e-government services between 1980 and 2017. Second, the main search used ISI, IBSS, ScieLO SA and SCOPUS electronic databases. Third, the eligibility criteria were informed by constructs such as: perceived risk; cultural values; and citizens' acceptance of e-government services. An additional review of older literature searches, in particular, the 1980s was conducted. Due to their out-datedness, those articles were graded in accordance with the degree of evidence for perceived risk, cultural values and citizens' acceptance of e-government services based on the central research question that reflected probable foundation of selection bias. Thus, any article included was added provided there was medium or higher evidence for a reasonable sample. As a consequence, all the full-text articles meeting the eligibility criteria were studied further, which paved the way for the extraction of relevant data, consequently yielding a total of 28 relevant articles.

That is, while many research studies on e-government services have been conducted on e-services in South Africa, one major challenge is the lack of a conjoint examination of the perceived ease of use, and the perceived risk for citizens' acceptance of e-government services (whether e-banking, e-health, e-education [m-learning], e-commerce, or e-tax), which has received little to no attention and has not been conducted together with the examination of the role of cultural values.

There are several systematic review processes, for example: critical review, literature review, mapping review/systematic map, meta-analysis, mixed studies review/mixed methods review. Others are overview, qualitative systematic review/qualitative evidence synthesis, rapid review, scoping review, state-of-the-art review. Some include: systematic review, systematic search and review, systematised review, and an umbrella review. Based on the concerns raised in this study, and the aims of the current study, a mapping review/systematic map (methodology) was chosen in preference to the other methods. The choice was also in response to a general critic or weakness of several methods, which may be associated with or are evident in such methods. The essence of this section was to discuss and prove that the conclusions were genuinely and methodically arrived at.

The methodology was grounded upon a review/systematic map due to the stated aim and the concerns raised regarding the topic. The motive hinged upon the fact that this type of systematic review process allows for mapping out and categorising already existing research. Wherein, new or further research could be commissioned, or additional reviews, as well as

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crucial research, be identified in the form of gaps, which was what the current research endeavoured to undertake. As a consequence, the completeness of searching of databases or literature was determined by the research's time and scope constraints, which in some cases were synthesised via graphical and tabular analysis. In simple terms, the review took the form of characterising fundamental features such as quantity and quality of past and present research by exploring 28 study designs, findings, and recommendations, and recommendations for future research.

Consequently, positioned upon theories guiding the perceived ease of use and the perceived risk as well as South Africans' cultural values, the current research examined citizens' acceptance of e-government services.

In addition to the integrity of the research, and to strengthen the rigour of the current study, the review of work and the selection of previous papers was positioned upon e-government services such as e-health, e-banking, e-education and e-filing. The study was also positioned upon various theories, but not limited to the following: Theory of Reasoned Action (TRA); the Theory of Planned Behaviour (TPB); the Technology Acceptance Model (TAM); the Diffusion of Innovation (DOI); the Unified Theory of Acceptance and Use of Technology (UTAUT); the Technology Readiness Index (TRI); Hofstede's cultural values; institutional logics theory; and privacy calculus model. Effectively, attention was given to e-government services both locally and internationally

Table 1. Methodology used for selecting previous work

Guiding Principles	Selected Theories	Guiding Themes
Perceived ease of use	TRA	e-Government services, scope and nature, effects of perceived ease of use and perceived risks, e-government services and influences of theories
	TPB	
Perceived risk	TAM	
	DOI	
Cultural values	UTAUT	
	TRI	
	Hofstede's cultural values	
	Institutional logics theory	
	Privacy calculus approach	

RESULTS AND DISCUSSION

BACKGROUND AND THEORETICAL EXAMINATION OF E-GOVERNMENT SERVICES

In the past decade, interest in understanding factors influencing citizens' adoption and continuous use of e-government services has noticeably gained attention (Wangpipatwong et al., 2008). In much the same way, various attempts have been made to comprehend the factors influencing citizens' continuous use of e-government services (Sarrayrih & Sriram, 2015; Yusuf-Dauda & Lee, 2015).

Additionally, regardless of the growing body of research on citizens' use of e-government services, the focus of the research has mainly been on countries such as Nigeria, Malaysia, the United Arab Emirates (UAE), Jordan, and Greece (Ibrahim et al., 2016; Alrashidi, 2012; Esmaeilzadeh, Sambasivan, & Nezakati, 2012; Zafiropoulos, 2012; Mofleh & Wanous, 2008).

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Moreover, a wide array of theories ranging from TRA, TPB, TAM, DOI, to UTAUT have extensively been applied in various forms.

However, one fundamental view is that the theories have mostly been used to unpack e-government's theoretical stance without considering other dimensions (Ibrahim et al., 2016; Alrashidi, 2012; Esmaeilzadeh, Sambasivan & Nezakati, 2012; Zafiropoulos et al., 2012; Mofleh & Wanous, 2008). For instance, while the aforementioned studies have expanded our understanding relating to e-government services and the use of theories, little to no evidence exists regarding the effects of the perceived ease of use and the perceived risk in combination with the roles of the cultural value in the acceptance of e-government services.

Thus far, most behavioural theories characterised as best practice models and as a standard of measure of technology adoption have primarily been TRI, TAM and UTAUT. Moreover, based on research conducted in 2017, "…personality traits of TR (Technology Readiness) [are said to be] significantly affected [by] the cognitive dimension of TAM, the perceived ease of use and the perceived usefulness," and that TRI was an "antecedent to the TAM model" (Adiyarta et al., 2017, p. 8).

Despite some significant attempts to determine factors, theories as well as research methods, results have thus far remained inconclusive, indecisive and varied. Additionally, given that existing literature, as reflected in Figure 1 demonstrates the current relationship, the reflection is that findings have so far been mixed.

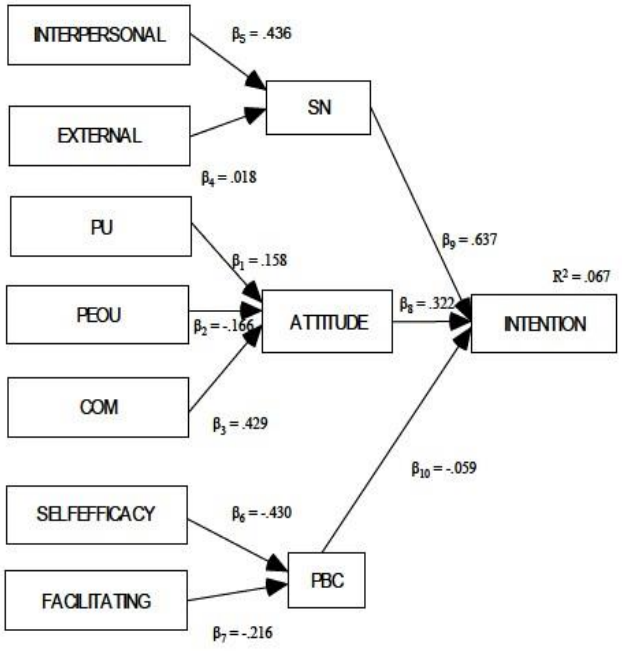

Figure 1. Existing model (Suki & Ramayah, 2010)

EFFECTS OF THE PERCEIVED EASE OF USE ON CITIZENS' ACCEPTANCE OF E-GOVERNMENT SERVICES

Research defines the perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). In the earlier section, it was also recounted that regardless of the nature or form of e-government service(s) (e-

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health, e-banking, e-education or e-filing), various behavioural theories such as TRA, TPB, TAM, DOI and UTAUT have all been used to expand the understanding of citizens' acceptance of e-government services. This includes, but is not limited to, the ease of login, access to the required information, the ease of completing a transaction, and the ease of following both the organisation and structure of e-government services. For example, one study used TAM and the DOI theories to investigate how determinants such as user acceptance, perceived risk and trust influence teachers' behavioural intentions to adopt e-government services in e-education (Zafiropoulos, 2012). The conclusion is that both the perceived ease of use and the perceived risk had been proposed to be fundamental determinants of citizens' continued use of e-government services. The evidence thus far also suggests that the perceived ease of use significantly influences both current usage and future usage of information systems. Consequently, it had also been reported in Thailand that perceived ease of use ($\beta = .188$; $t = 4.999$, $p < .001$), to some extent, contributes to the continued use of e-government services (Wangpipatwong et al., 2008). However, perceived ease of use has a lesser correlation with users' cultural settings (Wangpipatwong et al., 2008).

Potential Implication 1/Assessment

It can thus be conjectured from the examination of the literature that while the continued use of e-government services is fundamentally dependent on citizens' perception that using the service would be free of effort (perceived ease of use), other factors such as cultural setting and values play a crucial role in determining the acceptance of e-government services, and can enhance both theorists' and practitioners' understanding of e-government services adoption.

EFFECTS OF THE PERCEIVED RISK AND OTHER INFLUENCERS ON CITIZENS' ACCEPTANCE OF E-GOVERNMENT SERVICES

Consistent with the findings from previous studies on TAM, perceived risk and hence perceived uncertainty are some of the fundamental constructs that tend to characterise citizens' acceptance of e-government services (Davis, 1989, p. 320). Research suggested that "a high level of trust in the service, the technology, and the service provider may lead to perceived low risk in using the service, and thus increase the intention to use e-government services" (Susanto, 2013, p. 334). In another study, the conclusion reached is that given perceived usefulness, ease of use and positive attitude, the perceived usefulness is a better determinant than both the perceived ease of use or trust (Renny, Guritno & Siringoringo, 2013, p. 212). A study conducted by Hamid et al. (2016, p. 644) also demonstrates that "…perceived usefulness ($\beta = 0.65$, $p < 0.01$) and perceived ease of use ($\beta = 0.14$, $p < 0.05$) are positively related to the continued intention to use e-government services and able to explain a total of 56 % variance." The assertion could also be made as suggested by different studies that the "…perceived risk regarding tolerance of different cultures may determine their decisions to use or not use an e-government service, particularly for transactional use" (Susanto, 2013, p. 178).

Potential Implication 2/Assessment

What could be deduced and possibly verified is that citizens' continued use of e-government services also depends significantly on the perceived trustworthiness. However, this differs from culture to culture, and where the intended use correlates with the perceived risk. Consequently, citizens' continued use of e-government services is a function of trust by different cultures and the perceived risk.

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HOFSTEDE'S CULTURAL THEORY

It has to be established how a composite view of the effects of the perceived ease of use, and the perceived risk on citizens' acceptance of e-government services is explained or even measured (Mawela, Ochara & Twinomurinzi, 2017, 2016). For instance, while various studies have examined the determining factors, theories as well as research methods, none of the findings are universally conclusive. Instead, they are unanimous in their reports that the perceived ease of use and the perceived risk influence the different cultures' acceptance of e-government in South Africa (Mawela et al., 2017, 2016). Thus, further examination is imperative. This is because; perceived risk, which relates to privacy calculus, dictates that some level of rational processes influence the decision-making of any form of e-government service (Ibrahim et al., 2016; United Nations e-Government Survey, 2014; Munyoka & Manzira, 2013; Esmaeilzadeh, Sambasivan & Nezakati, 2012). Thus, suggesting that risks of using e-government services are a function of weighing anticipated risks against potential benefits. However, other authors suggest that thoughtful contemplation regarding privacy is constrained by inadequate means, heuristic and sometimes explorative or even experimental thought processes – see for instance studies that were conducted in the years between 1989 and 2013 (Hamid et al., 2016; Renny et al., 2013; Zafiropoulos, 2012; Wangpipatwong et al., 2008; Dimitrova, & Chen, 2006; Susanto, 2013; Davis, 1989).

Nevertheless, Hofstede's cultural theory also depicts a particular reference to different cultures, moderating factors. These may include: demographic factors, and other cognitive/psychological factors such as perceived risk, perceived uncertainty, trust, perceived quality of the information, perceived resources, facilitating dimensions/values of one's culture such as individualism and power distance (Hamid et al., 2016; Renny et al., 2013; Susanto, 2013; Zafiropoulos et al., 2012; Almahamid, Adams, Kalaldeh & Al-Sa'eed, 2010; Carter & Weerakkody, 2008; Wangpipatwong et al., 2008; Dimitrova & Chen, 2006; Davis, 1989; Anderson & Gerbing, 1988).

Potential Implication 3/Assessment

Conclusively, it will be essential to ascertain the degree of variation. That is, whether there is a need to explore the relationship or correlation between perceived risk, perceived uncertainty, trust, perceived quality of the information, perceived resources, facilitating conditions among different cultures of South Africa, and how they influence different cultural settings and the acceptance of e-government services in South Africa.

Potential Implication 4/Assessment

While there has been an abundance of research on cognitive/behavioural factors that have been examined *via* TRA, TPB, TAM, and UTAUT, which have all aided in expanding theorists' and practitioners' knowledge, little to no evidence exists regarding other factors such as the extended privacy calculus (perceived risk), Hofstede's cultural dimensions (cultural dimensions/values) of citizens of different settings, or the institutional logics theory. The examination using the extended privacy calculus, cultural aspects of citizens of different countries, and institutional logic is essential. This is because, these theories take into account the cultural factors, behavioural factors, and institutional factors in the assessment of citizens' acceptance of e-government services as opposed to focusing only on the behavioural factors (TRA, TPB, TAM, DOI, and UTAUT).

The conclusion is that a conjoint assessment of the behavioural factors such as the perceived ease of use, cultural values, perceived risk, and their effect on South Africans' acceptance of

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e-government services may enhance both theorists' and practitioners' understanding of e-government services adoption.

E-GOVERNMENT SERVICES IN SOUTH AFRICA: SCOPE AND NATURE

Even though it is not within the scope of the current study to examine legislation and frameworks, a few are noted due to their relevance to e-government services.

In South Africa, for example, various legislations and frameworks such as transforming public service delivery (TPSD), the Promotion of Access to Information Act (POPI), and the Electronic Communication and Transaction Act unanimously confirm that information security (which includes perceived risks) is paramount to citizens' acceptance of e-government services (Mawela et al., 2016). Other frameworks or standards include: the electronic government policy framework; the minimum information security standards (MISS); the minimum interoperability standards (MIOS); and the policy on free and open-source software (FOSS) (Mawela et al., 2017). In South Africa, the focus this far has been on G2G (government-to-government), G2BC (Government to Business & Citizen), and G2C (government-to-citizen) services (Mawela et al., 2016). Specifically, South African e-government services include, among others: e-Natis, an electronic vehicle and transport management system; the e-Justice programme, responsible for improving judicial processes; the e-Hanis programme for streamlining and integrating personal identification data in government departments via the use of unique identifiers; and the national automated archival information retrieval system (NAAIRS), which is responsible for facilitating access to archived public records.

Other services in South Africa include e-filing initiatives – electronic filing of tax returns with the South African Revenue Services (SARS). e-Health employs ICTs to treat patients, conduct research, educate students, track diseases and monitor public health. e-Education is guided by the Telecommunications Act, no. 103 of 1996, which led to the creation of an education network (EduNet) to connect all South African schools. The law enables a discounted e-rate by facilitating internet connections for educational institutions.

Potential Implication 5/Assessment

Considering the nature of services in South Africa, e-government services fundamentally require electronic transactions in a safe, secure and productive environment for e-transactions. However, because of challenges such as needed data protection being threatened by theft, online gambling and related activities such as collection, preservation and production of e-evidence, there is no doubt that behavioural factors alone may not suffice in the assessment of e-government services adoption. As such, the possible conclusion is that a conjoint assessment of behavioural factors such as the perceived ease of use, cultural values and the perceived risk and their joint effect on South Africans' acceptance of e-government services may improve e-government services in South Africa.

CONCLUSION AND POTENTIAL CONTRIBUTION

From the examination mentioned above and the five (5) potential implications/assessments, it is highlighted that the effects of the perceived ease of use, the perceived risk as well as cultural values and their impact on citizens' acceptance of e-government services remain unconfirmed and unsatisfactory. The five (5) potential implications form the fundamental determinants of citizens' adoption and continued use of e-government services.

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Another area of conclusion remains the appropriateness of the theories applied, taking into account the national culture. Ongoing studies have prevalently focused on the theories mentioned above, yet, none of these studies exploited other approaches related to a composite stance of the effects on citizens' acceptance of e-government. The principal reason to include theories such as the cultural dimensions' theories, related to Hofstede's cultural as imperative, is that not only does the acceptance of e-government service rely on cognitive factors, but also on cultural factors and the risk-benefit calculus (hence, privacy calculus).

FUTURE WORK AND HYPOTHETICAL STANDPOINT

Despite the ongoing usage of different theories, methodologies and determinants, it is still inconclusive as to how in South Africa, e-government is affected by the perceived ease of use, and the perceived risk on citizens, nor is there research that establishes how the extended privacy calculus and cultural dimensions' impact citizens' acceptance of e-government services. Thus, many contestations remain unresolved. Effectively, the hypothetical standpoint that may require future work is as follows:

H1: e-Government adoption is fundamentally dependent on citizens' perception of ease of use and their cultural setting.

H2: Citizens' adoption and continuous use of e-government services is a function of trust, different cultural values and perceived risks.

H3: The degree of variations of perceived risk, perceived uncertainty, trust, perceived quality of the information, and perceived resources correlate with the values of different cultures.

H4: From a theoretical perspective, a conjoint assessment of behavioural theories, privacy calculus theories and Hofstede's cultural dimensions may improve the scope and nature of e-government services in South Africa and hence, enhance both theorists' and practitioners' understanding of e-government services adoption.

REFERENCES

Abbas, H.A. & Hamdy, H.I. (2015). Determinants of a continuance intention factor in the Kuwait communication market: Case study of Zain-Kuwait. *Computers in Human Behavior,* 49(0), 648-657. Adiyarta, K., Napitupulu, D., Nurdianto, H., Rahim, R., & A Ahmar (2017). User acceptance of egovernment services based on the TRAM model. *Materials Science and Engineering,* 1- 10.

Almahamid, S., Adams, A.C.M., Kalaldeh, T.A., & Al-Sa'eed, M. (2010). The relationship between perceived usefulness, perceived ease of use, perceived information quality, and intention to use egovernment. *Journal of Theoretical and Applied Information Technology*, 30-44.

Alrashidi, A. (2012). User acceptance and motivation of e-government services based on employees' levels of experience in the UAE SME. *American Journal of Economics, 2*(6), 132-135.

Anderson, J. C. & Gerbing, D.W. (1988). Structural equation modelling in practice: A review and recommended two-step approach. *Psychological Bulletin,* 103, 411-423.

Belanche, D., Casaló, L.V., & Flavián, C. (2012). Integrating trust and personal values into the technology acceptance model: The case of e-government services adoption. *Cuadernos de Economía y Dirección de la Empresa,* 15(4), 192-204.

Carter, L. & Weerakkody V. (2008). E-government adoption: A cultural comparison. *Information Systems Front,* 10, 472-482.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly/September,* 319-340.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Dimitrova, D.V. & Chen, Y.C. (2006). Profiling the Adopters of E-Government Information and Services. *Social Science Computer Review*, 24(2), 172-188.

Enticott, J.C., Shawyer, F., Vasi, S. *et al.* (2017). A systematic review of studies with a representative sample of refugees and asylum seekers living in the community for participation in mental health research. *BMC Med Res Methodol* 17**,** 37

Esmaeilzadeh, P., Sambasivan, M., & Nezakati, H. (2012). The limitations of using the existing TAM in adoption of clinical decision support system in hospitals: an empirical study in Malaysia *Int. J. Res. Bus. Soc. Sci.* 3, 56–68.

Fornell, C. & Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* 18, 39-50.

Hamid, A., Razak, F.Z.A., Bakar, A.A., & Abdullah,. W.S.W. (2016). The effects of perceived usefulness and perceived ease of use on continuance intention to use e-government. *Procedia Economics and Finance,* 35, 644 – 649.

Ibrahim, J.S., Taib, C.A., & Shahzad, A. (2016). The behavioural Intention of citizen of Nigeria on e-government services by utilization of the unified theory of acceptance and use of technology (UTAUT). *Sains Humanika,* 8, 41-6.

Kitchenham, B. and Brereton, P. (2013). A systematic review of systematic review process research in software engineering. Information and software technology, 55(12), pp.2049-2075.

Lin, W.S. & Wang, C.H. (2012). Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit. *Computers & Education,* 58(1), 88-99.

Mawela, T., Ochara, N.M., & Twinomurinzi, H. (2017). E-government implementation: A reflection on South African municipalities. *South African Computer Journal, 29*(1), 147–171.

Mawela, T., Ochara, N.M., & Twinomurinzi, H. (2016). E-Government implementation: Lessons from South African municipalities. In *Proceedings of the Annual Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT '16), Johannesburg, South Africa.* ACM.

Mofleh, S. & Wanous, M. (2008). Understanding factors influencing citizens' adoption of e-government services in the developing world: Jordan as a case study INFOCOMP. *Journal of Computer Science,* 7(2), 1-11.

Munyoka, W. & Manzira, F.M. (2013). Alignment of e-government policy formulation with practical implementation: The case of sub-Saharan Africa. *Int. J. of Social, Behavioural, Educational, Economic, Business and Industrial Eng.* 7, 3034-39.

Renny, S., Guritno, C., & Siringoringo, H. (2013). Perceived usefulness, ease of use, and attitude towards online shopping usefulness towards online airlines ticket purchase. *Procedia - Social and Behavioural Sciences,* 81, 212 – 216.

Sarrayrih, M.A. & Sriram, B. (2015). Major challenges in developing a successful e-government: A review on the Sultanate of Oman. *Journal of King Saud University - Computer and Information Sciences*, 27(2), 230-235.

Schaupp, L.C., Carter, L., & Hobbs, J. (2010). Electronic tax filing: The impact of reputation and security on adoption. *Proceedings of the 43rd Hawaii International Conference on System Sciences.*

Suki, M. & Ramayah, T. (2010). User acceptance of the e-government services in Malaysia: structural equation modelling approach. *Interdisciplinary Journal of Information, Knowledge, and Management,* 5, 395-413.

Susanto, T.D. (2013). Individual acceptance of e-government: A literature review. *SDIWC*, 334 – 342.

UN United Nations E-Government Survey (2014). *e-Government for the future we want*. 2014 United Nations Department of Economic and Social Affairs.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Wangpipatwong, S., Chutimaskul, W., & Papasratorn, B (2008). Understanding citizens' continuance intention to use the e-government website: A composite view of the technology acceptance model and computer self-efficacy. *The Electronic Journal of e-Government, 6(*1), 55 – 64.

Yusuf-Dauda, S. & Lee, J. (2015). Technology adoption: A conjoint analysis of consumers′ preference on future online banking services. *Information Systems,* 53(0), 1-15.

Zafiropoulos, K., Karavasilis, I., & Vrana, V. (2012). Assessing the adoption of e-government services by teachers in Greece. *Future Internet*, *4*, 528-544.

ISBN Electronic: 978-0-6399275-6-5
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THE IMPACT OF CYBERSECURITY THREATS ON E-GOVERNMENT IN DEVELOPING COUNTRIES: A CASE OF SOUTH AFRICA

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ABSTRACT

Aim/Purpose The objective of the current research is to examine the impact of cybersecurity threats on e-government in developing countries.

Background While there has been a growing need for e-government services in developing countries, cybersecurity risks remain a significant threat and insufficiently researched. In developing countries, citizens' confidence in the security of their data and reliance on e-government remain a severe concern with particular reference to cybersecurity threats. Guided by tools of cybersecurity such as a secure socket layer and secure electronic transactions, the current research examines the impact of cybersecurity threats on e-government services in a developing country.

Methodology In response to the growing concern, the method used in the analysis of the current study was through a systematic examination of the literature on citizens' acceptance of e-government services with particular focus on cybersecurity threats, citizens' confidence in the security of their data and reliance on e-government as well as the identification of critical cyber risks.

Findings Based on the systematic review, various propositions and potential values were recommended regarding cybersecurity. However, due to the systematic review nature of the current work, it is only limited to highlighting the potential impact of cybersecurity on e-government in developing countries and their related implications. Consequently, there is a need for an empirical investigation in developing nation(s) to affirm or refute the repercussions.

Keywords e-Government; Cybersecurity; South Africa; Developing country.

INTRODUCTION

There has been a growing and evolving need to enhance the privacy and security of electronic government services (whether e-banking, e-health, e-education (m-learning), e-commerce or e-tax). This growing concern is in respect to cybersecurity risks, particularly in developing countries. This need has partly arisen because of the advent of cybersecurity risks associated with: (1) mobile commerce (Chou, Lee & Chung, 2014; Carlsson, 2001); and (2) the speed and security of mobile payment transactions or systems (Xu, Zhang, Zeng, Wan & Wu, 2015; Jackson, 2012; Bilal, 2011; Weigold & Hiltgen, 2011; Bangdao & Rosco, 2010; Gordon & Sankaranarayanan, 2010; Vasileiadis, 2000).

In developing countries, various reasons have been attributed to the phenomenon of e-government being at risk with some propositions (Xu, 2015; Jackson, 2014; Vasileiadis, 2014; Bilal, 2011). However, due to the nature of e-government services, the one concern that has

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received considerable attention is that mobile devices are a target of choice. That is, attacks may be the result of exploiting the weaknesses in wireless communication technologies such as wireless fidelity (Wifi) networks and the global system for mobiles (GSM) (Vasileiadis, 2014; Bilal, 2011). Other widely recognised weaknesses are vulnerable software; that may be via the e-government web browsers (whether used in e-banking, e-health, e-education (m-learning), e-commerce, or etax) in the form of client and operating systems (Vasileiadis, 2014; Bangdao & Rosco, 2010). Other end-users may introduce a malicious software attack based on their insufficient knowledge regarding hacks or attacks (Daştan & Gürler, 2016; Jackson, 2014; Weigold & Hiltgen, 2011; Gordon & Sankaranarayanan, 2010).

Taking cognisance of the vulnerabilities mentioned regarding e-government services, and based on some wide-ranging results and some seemingly contestable findings, both past and present studies have made references to the cyber threats associated with e-government services (Pegueros, 2014; Ron & Shamir, 2013; Schierz, Schilke & Wirtz, 2010). The reaction by citizens for being concerned about such potential and real vulnerabilities associated with e-government services is a widespread lack of confidence—accordingly, a slow adoption rate of e-government services (Pegueros, 2014). For instance, it was reported that 48% do not use e-banking (a service of e-government) because of concerns associated with the security of e-banking and thus e-government (Pegueros, 2014, p.13). In fact, in response to feeling the need to protect personal information, about a third (32%) lamented that e-government services are “very unsafe”; another third (34%) noted that they were “…not sure of the security” (Pegueros, 2014, p.13). These statistics highlight the need to examine the cybersecurity risks of e-government services in developing countries such as South Africa.

RESEARCH AIM

Within and beyond the borders of the African continent, a steady stream of research dating back to the 1990s endeavoured to account for the constraints on mobile systems, with increasing attention being given to e-government, but with no clearly defined results or consensus (Daştan & Gürler, 2016; Mbogo, 2015; Ndii, 2013; Avivah, 2011; Pousttchi & Wiedeman, 2008; Venkatesh, Morris, B. Davis, & D. Davis, 2003; Herzberg, 2001; Jayawardhena & Foley, 1998; Shon & Swatman, 1997). That is, while there has been a growing need for e-government services in developing countries, cybersecurity risks remain far less researched (Pegueros, 2014). This is particularly true in developing countries with specific reference to cybersecurity threats and citizens’ lack of confidence regarding the security of their personal data, and potential exposure of confidential data. Additionally, critical cyber risks were feared to concern online payment systems and the whole security infrastructure. Guided by tools of cybersecurity such as secure socket layers and secure electronic transaction, and through a systematic examination of literature, the current research aims to examine the impact of cybersecurity threats on e-government services in a developing country.

METHOD: SYSTEMATIC LITERATURE REVIEW PROCESS

The method was informed by the application of systematic review of present academic and older literature (Kitchenham & Brereton, 2013; Enticott et al., 2017). That is, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was adhered to, hence following specific account for conducting as well as reporting a systematic review (Enticott et al., 2017). In simple terms, this was informed by the relevance of the research

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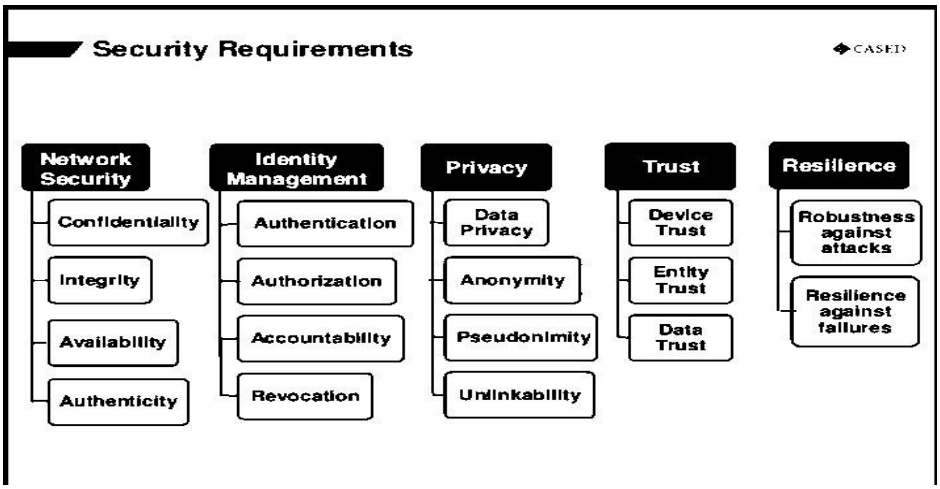
related to the impact of cybersecurity threats on e-government in developing countries between 2000 and 2017. The main search used ISI, IBSS, ScieLO SA and SCOPUS electronic databases. The eligibility criteria were based on examination of constructs such as: cybersecurity threats and e-government services, citizens' level of confidence and reliance on e-government. Attention was also given to both e-government services and their role in online payment systems as well as vital cyber risks affecting developing nations' e-government services. Other sections include security infrastructure and e-government services. Lastly, attention was drawn to the potential value of cybersecurity in developing countries and their effects on e-government services. An additional review of the older literature search in the 2000s was conducted. As they appeared outdated, such articles were rated, taking into account the degree of evidence for cybersecurity threats on e-government. This was informed by primary research constructs that may reflect probable bases for the selection bias. Thus, any article included was added provided there was medium or higher evidence for a reasonable sample. As a consequence, all the full-text articles meeting the eligibility criteria were studied further, which paved the way for the extraction of relevant data, consequently yielding a total of 49 relevant articles.

RESULTS AND DISCUSSION

BACKGROUND – CYBERSECURITY THREATS AND E-GOVERNMENT

Arguably, e-government services are contingent upon reliability and the end-users' confidence. That is, for secure socket layer (SSL) and secure electronic transaction (SET) to work, e-government services have to address and meet adequate security requirements (van der Heijden, 2002, p. 17). One of these requirements is authentication, as depicted in Figures 1 and 2 (cyber-physical systems - CPS). Authentication is a technique that helps in the identification of citizens before they start to use any of the e-government services. An important consideration is for e-government services to be offered with integrity, as this ensures that information about the citizens will not be altered or ruined during the process of interaction. Non-repudiation, on the other hand, ensures, for instance, protection against "…unjustifiable denial of placed orders or unjustifiable denial of past transactions (van der Heijden, 2002, p. 17). Confidentiality ensures "…private or confidential information is not available or disclosed to unauthorised…" citizens (van der Heijden, 2002, p. 17). Lastly, authorisation requires verification when citizens make a transaction (van der Heijden, 2002, p. 17).



Figures 1. Security Requirements (adapted from Rehman et al., 2018).

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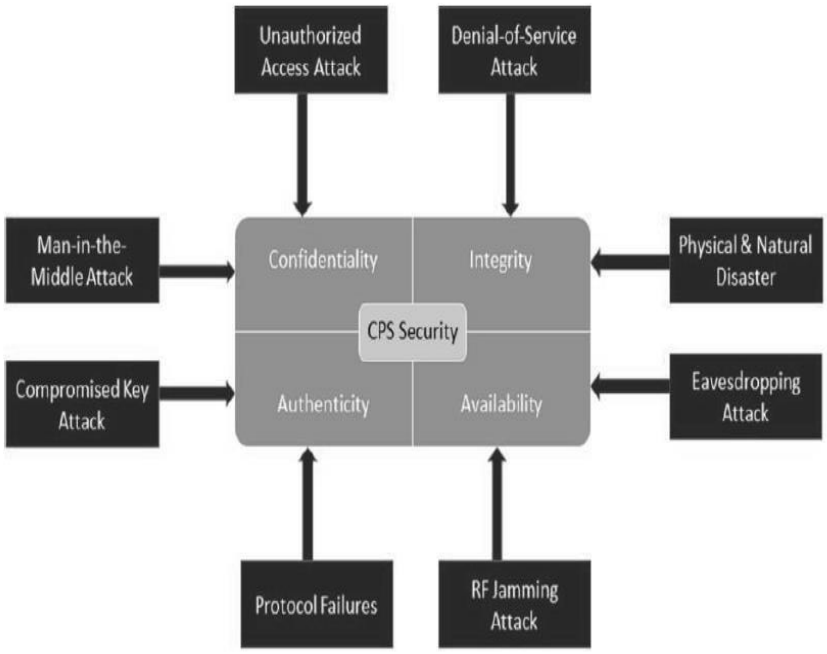

Figure 2. Security goals and threats (adapted from Rehman et al., 2018)

Despite the studies that had been conducted in the late 1990s and the early 2000s (Chou, Lee, & Chung, 2004; Jayawardhena & Foley, 1998; Shon & Swatman, 1997), it was frequently reported that there is still a lack of research, for instance, into how developing countries such as South Africa accounts for and deals with the application and effects of cybersecurity and its role in e-government services. While SSL is present on citizens' or customers' browsers, SET protocols serve as comprehensive security protocols (van der Heijden, 2002, p. 17). It has to be noted that SET protocols have been characterised as providing privacy, authenticity, integrity, and non-repudiation (van der Heijden, 2002, p. 17). However, examining the relationship between SSL and SET protocols has not been able to provide a clear understanding of the level of threats (Daştan & Gürler, 2016; Avivah, 2011; Pousttchi & Wiedemann, 2008; Herzberg, 2003; Mbogo, 2010).

Potential Implication 1

From the explanations presented above regarding the security requirement/goals, it could be questioned whether attacks such as brute force, keyloggers and malware are preventable for any

e-government service. Additionally, from Figures 1 and 2, could it be possible that security requirements/goals collectively classified under network, identity management, privacy, trust, and resilience, take care of the threats posed by e-government?

CITIZEN'S CONFIDENCE AND RELIANCE ON E-GOVERNMENT

Following Figure 1 and acknowledging that this is the expectation of SET and possibly SSL, it begs one question related to SET and SSL. That is, whether SET and SSL sufficiently address authentication,

non-repudiation, confidentiality, integrity, anonymity and reliability? This question is essential

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considering the increasing level of mistrust among South Africans and other developing countries in the system (Mbogo, 2015; Kim, Mirusmonov & Lee, 2010).

Potential Implication 2

A possible effect that still arises as a consequence of the first is whether these security or cyber threats are adequately addressed, particularly regarding e-government services. These two implications are discussed, based on reports of related work dating back to the 1980s, but with an emphasis on the work of several other relevant authors (Bohle & Krueger, 2017; Daştan & Gürler, 2016; Pegueros, 2014; Ron & Shamir, 2013; Zhou, 2013; Hampe & Swatman, 2011; Kim et al., 2010; Carlsson, 2001, Jayawardhena & Foley, 1998; Shon & Swatman, 1997).

KEY CYBER RISKS AFFECTING DEVELOPING NATIONS' E-GOVERNMENT SERVICES

The listed implications (questions) underscore and necessitate the examination of crucial cyber risks affecting developing nations' e-government. For instance, research identified nine (9) major cyber threats to e-banking – a service of e-government (Pegueros, 2014, p. 13). These include "malicious applications, privacy violations relative to application collection and distribution of data, wireless carrier infrastructure, payments infrastructure/ecosystem, Short Message Service (SMS) vulnerabilities, hardware and operating system vulnerabilities, lack of maturity of fraud tools, and controls" (Pegueros, 2014, p. 13).

For instance, the frequency of malware purposely designed to affect e-government services has inched up 6.4 times since 2011, with enormous numbers of threats related to mobile backdoors affecting Android devices (Pegueros, 2014, p. 13). Thus, such attacks compromise the very integrity of the application. Another leading effect and thus a serious risk of compromised integrity of an application is jailbreaking, "…which is a form of privilege escalation that allows an attacker to gain root access [to e-government]. In effect, this allows access to all files, hidden files or protected files…" (Pegueros, 2014, p. 13).

Consequently, a jailbreak gives access to the device by installing another application-sanctioned store of the device's manufacturer (Pegueros, 2014, p. 13). Network carriers often lock devices onto their network, and this implies that the jail-breaker will be able to phone by utilising the wireless carrier of the jailbroken device intended for any e-government service such as e-banking. SMS may be redirected for unintended purposes, where hijacking and spoofing of messages and information may also occur.

Potential Implication 3

Being aware of the possibilities of such hacks, this also begs the question regarding citizens' guaranteed level of confidentiality, authentication, and anonymity of e-government services. In most developing countries, these questions are as yet to be examined and adequately resolved.

In support of the quest for such critical examinations, another study extended the request for the urgent need for further research by signifying that "…the lack of security [and citizens'] trust hampers the adoption of online payment systems (OPS) and thus e-government (Bezhovski, 2016, p. 130). Agreeing with such request, some authors highlight the notion that "[citizens] need confidentiality, authentication, data integrity, and non-repudiation as key requirements for making secure payments over the internet" to prevent other reported cyber risks. Thus, there is a distinct position requiring the need to improve the cybersecurity systems associated with e-government services to avoid risks such as stolen data or identity theft.

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E-GOVERNMENT AND ITS ROLE IN ONLINE PAYMENT SYSTEMS

Analysis of some studies suggests a small, but increasing level of popularity gained by e-government services this far is in part due to the online view of conducting business (Bezhovski, 2016; Chou et al., 2014; Gordon & Sankaranarayanan, 2010; Yang, Wang, Ren & Wang, 2010). There are also many forms of OPS (e-wallets, e-payment cards [debit, credit, and charge cards], virtual credit cards, mobile payments, loyalty and smart cards and e-cash). All of these serve as a storedvalue card payment in the form of "account-based and electronic currency systems [ECS]" (Bezhovski, 2016; Chou et al., 2014; Gordon & Sankaranarayanan, 2010; Yang, Wang, Ren & Wang, 2010). While account-based systems allow citizens to make payments through their bank accounts, ECS enables the right of ownership of sufficient electronic currency.

Potential Implication 4

Regardless of e-government's benefits via such channels such as e-banking and the other stated systems, it is highlighted that such systems are inherently risky and are believed to be so by most citizens (Kim et al., 2010). There is still evidence that demonstrates the limited use of some e-government systems because of their claimed lack of privacy and secured OPS. Consequently, it could be argued that the need to re-access the security and privacy concerns of the OPS could facilitate faster adoption of OPS, with a particular focus on the advancement of e-government services.

In addition to the already stated risks associated with the use of e-government services in developing countries, there are well over "…fifty thousand (50,0000) different types of computer viruses, malicious internet programs, and Trojans" (Bilal, 2011, p. 2). These numbers are believed to be growing daily. Accordingly, due to the increasing threat of cybersecurity risks in developing countries, e-government services are claimed to experience the most dangerous attacks through SMS communication during e-banking. Another risk is the "… spoofing attack, where the attacker [could] send messages on the network by manipulating the sender's number." For that reason, in most developing countries "… most of the [e-government services], if they exist, are not adopting mobile banking through SMS." Authors also note that "…software such as Trojan horses could easily take up a password on the web browser or any cached information on the operating system." Moreover, "…malicious codes are written for remote communication," and others such as the "Zeus Trojan target mobile bank users" (Bilal, 2011, p. 2). For instance, Zitmo is used to defect SMS banking, whereas Zeus enables an attacker to "…steal the mobile transaction authentication number or password" (Bilal, 2011, p. 2).

Potential Implication 5

Considering all the challenges stated above, it is problematic for e-services to operate safely and efficiently in developing countries such as South Africa. For instance, "the Standard Bank in South Africa uses a wireless internet gateway (WIG), and First National Bank uses an SMS-based approach for mobile banking" (Bilal, 2011, p. 2). The previously stated weaknesses in the systems and the risks, therefore, can be exploited when citizens send personal identification numbers (PIN) meant for the e-government (e-banking) servers. The fact that the server accepts the request and data is transmitted with full access in the hands of the network operator, means the approach is not fully secured.

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SOME SECURITY INFRASTRUCTURE AND E-GOVERNMENT

Security of infrastructure of e-government services has been receiving significant attention due to several setbacks (Nathaniel, 2015; Vasileiadis, 2014). Although it is not within the scope of the current study to address such security risks associated with the technical infrastructure of e-government, it is still worthwhile to mention that technologies such as the wireless public key infrastructure (WPKI) and the universal integrated circuit card (UICC), which are responsible for recognising fingerprints, also have some challenges. This challenge further contributes to e-government setbacks. Due to the drawback of the WPKI and UICC technology for fingerprint, a 3-factor authentication (3FA) process has been proposed. That is, Android mobile devices based on 3FA, for instance, use three factors for their verification processes (Vasileiadis, 2014). However, the drawback is the need to use some particular universal mobile telecommunications service (UMTS) subscriber identity module card (USIM card) for the end-users' authentication. This limits the adoption of m-computing and therefore, the use of e-government services such as e-banking. Such facilities or technologies (GSM, WLANs, and GPS) could even be used by the government or other actors for tracking citizens through a process called mobile telephony "…by using the [citizens'] wireless device to transmit the [persons'] location to network operators" (Vasileiadis, 2014). The technologies could also be used for "…user preferences…" in that "… there is potential for high-proliferation and personalisation of the available data."

Potential Implication 6

Drawn from the discussion, it is clear that unauthorised access to citizen's information via the SIM card and card cloning could compromise the e-government services infrastructure. The compromised e-government services infrastructure could also lead to data being stolen from log files. Thus, where e-government infrastructure is not able to counter such defects or weaknesses, the data being taken may come as a result of citizens storing their passwords in their phones. This concern has also been raised and discussed by some authors (Pukkasenung & Chokngamwong, 2016; Bilal, 2011; Mbogo, 2010). The discussion revolved around drawing attention to the fact that "if the device gets stolen, then the hackers or unauthorised persons may find the password to the banking details from the log files or saved draft files" (Bilal, 2011, p. 2). This is mainly because, the password is sometimes kept under "…auto fill settings…" and that this may lead to the inappropriate and mistrust of e-services, particularly among uneducated citizens. In summary and following the identified gaps in research, there is overwhelming evidence that the e-government infrastructure still requires further examination, particularly in developing countries' cyber-infrastructure, the safety of the systems and the effectiveness.

OTHER INFLUENCING FACTORS OF E-GOVERNMENT AND CYBERSECURITY

Several authors in developed countries have studied the factors that influence the success of an internet system as well as cybersecurity's role in e-government services (Jackson, 2012; Kim et al., 2010; Turban & King, 2002; Turban & Brahm, 2000; Jayawardhena & Foley, 1998; Shon & Swatman, 1997). The authors' works fundamentally evaluated the effective criteria and types of requirements for internet systems. This included; cybersecurity's role in e-government and by assessing intention to use e-government services in the form of e-commerce. Some studies argue that "…the traditional alternatives available for citizens to pay for a product are… a challenge" (Kim et al., 2010). The reasons advanced are that "…most mobile payment systems provide the service free to…" citizens. However, a position assumed is that "… mobile payment systems compete with cash for the [citizens'] favour…," while it

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cautions that "… the consumer places value on one payment system by taking into account the value offered by the competition" (Kim et al., 2010, p. 430).

Potential Implication 7

It can be drawn from the work of Kim et al. (2010) that there is some form of association between cost and ease of use – a contestation between traditional cash and mobile payment systems as part of e-commerce (e-government service). Even though developed nations such as the Netherlands and Britain report that mobile payment via e-government is becoming more frequently accepted, nonetheless, there has been a concern that "…no standardised… and widely adopted mobile payment system has been recognised as yet (Sueng & Liao, 2012; Kim et al., 2010; Hu, Krevatin, 2010). The consequent challenge is the limited acceptance that constrains the prevalent use of e-government transactions. In evaluating the studies further, it was revealed that "… the convenience of the money transfer technology plus its accessibility, cost, and support" play a greater role in e-government services. Thus, concluding that "intention to use and actual usage of the mobile payment service heightens the development of … industries (micro-business)."

Potential Implication 8

While there has been ongoing research primarily based on the "…causal relationship between finance …" and e-government services alike, research laments that "…studies on this subject suffer from the limitation of relying on cross-sectional data, which cannot satisfactorily address the country-specific issues" (Kisaka et al., 2015, p. 156). Research also argues that "…the problem of using a cross-sectional method is that grouping together countries that are at different stages of e-government development and growth fails to address the country-specific effect of e-government (Kisaka et al., 2015, p. 156).

Drawing from the Technology Acceptance Model (TAM) for example, it could thus be explained that "… when [citizens] are presented with new technology, many factors influence their decision about how and when they will use it" (Davis, 1989, p. 20). Additionally, "…security concerns, cost, convenience, and satisfaction…" remain prominent, if adopting e-government services is to be successful (Davis, 1989, p. 189). For instance, consistent with the TAM model, it was recounted that factors such as "mobile banking technology β = -.348; t = -4.289; p = <.000; liquidity β = .436; t = -5.187; p = <.000; deposits mobilised through mobile banking innovations β = .711; t = 6.593; p = <.000; size of the company β = .711; t = 6.593; p = <.000; volume of transactions that are handled through mobile banking annually β =.406; t = 5.445;" influence mobile payment and thus e-government adoption (Kisaka et al., 2015, p. 169). Consequently, there is the need to examine the adoption of mobile payment and thus, the potential success of the adoption of e-government services.

THEORETICAL STANCE (MODEL)

Even though the current research does not particularly suggest a specific theoretical framework, it endeavours to highlight those that have been applied already as a cautionary note. Thus, e-government services adoption-related research has been evaluated via different types of theories, including the Technology Acceptance Model (TAM). Others include the Theories of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB). It is well known that these theories have dominantly been used to explain and comprehend how information systems (IS) (new technology) are adopted and used (Montoro-Ríos, 2017; Yang, Lu, Gupta, Cao, & Zhang, 2012; Yang, 2010). It is also established through both TRA and TPB that

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attitude and subjective norms closely correlate with an individual's intention to adopt IS, which hinges on the individual's behavioural and normative beliefs (Montoro-Ríos, 2017, p. 894).

It is these theories that paved the way for the development of TAM (Davis, 1989), and which suggested that perceived usefulness, together with ease of use, are determinants of developing countries' cybersecurity and e-government roles. Drawing from other numerous studies (Gareth, 2017; Luna, Montoro-Rios, & Liebana-Cabanillas, 2016; Luna, 2012; Ervasti & Helaakoski, 2010; Liebana-Cabanillas, 2012; Abrazhevich, 2004), there are good grounds, as suggested by Montoro-Ríos (2017, p. 894), that the TAM model, which has been used extensively to explore online services, mobile phones, mobile ticketing, social networking, healthcare information systems, mobile payments and thus e-government services, is suitable. Therefore, there is evidence that the different theories tend to be applied for various purposes, as suggested by the multiple authors. For instance, some studies (Pousttchi & Wiedemann, 2008; Ajzen, 1991) suggested the use of TPB to examine behavioural control and social norms, whereas TRA and TAM2 examine subjective norms, which in this instance may be considered unsuitable for the current research since the thrust is on cybersecurity and e-government. Furthermore, a unified theory of acceptance and use of technology (UTAUT) tends to scrutinise social influence constructs, which are in part deemed inappropriate for the current research.

Potential Implication 9

Considering confidentiality as an essential feature of the cybersecurity construct and a feature that is essential for anyone considering to adopt e-government services, the argument is that confidentiality enables and secures transaction information or data that others are not allowed to view. Based on the feature of security, it could be argued that when citizens trust that their personal information is kept confidentially at all times, this enables their adoption of e-government services. On the other hand, when such cybersecurity issues stop citizens from using the e-government services, the procedure itself becomes less useful to the citizens, and so do authentication, non-repudiation, integrity, and anonymity.

Potential Implication 10

Based on the reasoning above, it could be propositioned that confidentiality as a construct of cybersecurity positively affects e-government services; and authentication as a construct of cybersecurity positively affects e-government. While it appears obvious both in practice and in theory for confidentiality as well as authentication, factors such as non-repudiation, integrity, and anonymity have not received such obvious affirmation. Consequently, the question that remains is whether integrity, non-repudiation, and anonymity also positively affect e-government services and the adoption of such services.

POTENTIAL VALUE TO DEVELOPING COUNTRIES' CYBERSECURITY AND E-GOVERNMENT

The propositions or the potential implications formulated were established on the concept of objective and subjective cybersecurity stance. The lessons that could be of value to developing countries is to distinguish and characterise cybersecurity within the two dimensions: objective and subjective security. Consequently, for e-government services to reach their full potential value and adoption, objective security should be seen as a concrete technical characteristic. One that gives a high degree of certainty as to when a certain technological solution responds to all of the five (5) security objectives, namely: confidentiality, authentication, integrity, authorisation, and nonrepudiation.

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CONCLUSION AND LIMITATION

Drawing from the standpoint of cybersecurity being a vital consideration in the use of e-government services, the recommendation is that objective and subjective cybersecurity should not be seen as disjointed aspects in accessing cybersecurity and e-government of developing countries. Understanding the cybersecurity ecosystem plays a critical role in addressing e-government services, which are exposed to the evolving and new cybersecurity risks affecting all new technology and thus e-government services.

Thus far, it could be concluded that developing countries' citizens require improved services, amongst which include government applying control in terms of the services offered through e-government – which is potentially affected by cybersecurity threats. While such challenges cannot be discounted in developed nations, in developing countries, old-fashioned cybersecurity controls in the form of firewalls together with encryption lack the considerable level of maturity required to combat e-government's cybersecurity threats. An additional conclusion is based on methodology, as this methodology is characterised by citizens' confidence in being able to rely on e-government, where key cyber risks affect developing nations' e-government services and their security infrastructure.

However, due to the systematic review nature of the current work, it is only limited to highlighting the potential impact of cybersecurity on e-government in developing countries and their related implications, as such, a follow up empirical investigation in developing nation(s) to affirm or refute the implications is required for future work or examination.

REFERENCES

Avivah, L. (2004). Best Practices in Mobile User Authentication and Layered Fraud Prevention *ACM*, 48(8), 1-12

Abrazhevich, D. (2004). *Electronic Payment Systems: A User-Centered Perspective and Interaction Design*. Netherlands: Technische Universiteit Eindhoven.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.

Bangdao, C. & Rosco, A.W. (2010). *"Mobile Electronic Identity: Securing Payment on Mobile Phones."* : 5th IFIP WG 11.2 International Workshop, WISTP 2011, Heraklion, Crete, Greece, June 1-3, 2011. Proceedings (pp.22-37)

Bezhovski, Z. (2016). The Future of the Mobile Payment as Electronic Payment System. *European Journal of Business and Management*, 8(8). 127 -132.

Bilal M. (2011). *Trust and security in mobile banking and its effects on customers*. Master's Thesis**,** Blekinge Institute of Technology.

Bohle, K. & Krueger, M. (2000). Electronic payment systems: strategic and technical issues. Seville, Electronic Payment Systems Observatory (ePSO), Available at, http://epso.jrc.es: 20 [Accessed 11 July 2017].

Chou, Y., Lee, C., & Chung, J. (2004). Understanding m-commerce payment systems through the analytic hierarchy process. *Journal of Business Research*, 57, 1423-1430.

Carlsson, C. (2001). Mobile commerce: core issues, products, and services. *Paper at the Bled Electronic Commerce Conference*, Bled, Slovenia. Clemons.

Daştan, K & Gürler, C. (2016). Factors Affecting the Adoption of Mobile Payment Systems: An Empirical Analysis. *Emerging Markets Journal*. 6(1), 15 -24.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and consumer acceptance of information Technology. *MIS Quarterly*, 13(3), 319–340.

Enticott, J.C., Shawyer, F., Vasi, S., Buck , K., H. I, Cheng , Russell , G., Kakuma, R., Minas, H. & Meadow, G. (2017). A systematic review of studies with a representative sample of refugees and asylum seekers living in the community for participation in mental health research. *BMC Med Res Methodol* 17**,** 37.

Ervasti, M. & Helaakoski, H. (2010). A case study of application-based mobile service acceptance and development in Finland*. International Journal of Information Technology and Management*, *9*, 243– 259.

Gareth, M. (2012). "Mobile malware rises by 155 percent as Android platform risks grow", Available at http://www.v3.co.uk/v3-uk/news/2153026/mobilemalware-rises-155-cent-android-platform-risksgrow [Accessed on June 2017].

Gordon, M. & Sankaranarayanan, S. (2010). Biometric security mechanism in Mobile payments, *Paper at the 7th International Conference On* Wireless *and Optical Communications Networks (WOCN),* 1-6.

Hampe, J.F. & P., Swatman. M.C. (2001). Mobile payment: opportunities, challenges, and solutions. *Paper at the Bled Electronic Commerce Conference*, Bled, Slovenia.

Herzberg, A. (2003). Payments and Banking with Mobile Personal Devices. *Communications of the ACM,* 46(5), 53–58.

Hu, J.Y., Sueng, C.C, Liao, W.H. (2012). Android-based mobile payment service protected by 3-factor authentication and virtual private ad hoc networking [C]. *Computing, Communications, and Applications Conference (ComComAp), IEEE*, 2012, 111-116.

Jackson, A. (2014). Analysis of Security Issues in Electronic Payment Systems. Nigeria. *International Journal of Computer Applications*, 108(10).

Jayawardhena, C. & Foley, P. (1998). Overcoming constraints on electronic commerce: Internet payment systems. *Journal of General Management,* 24(2), 19-35.

Kim, C., Mirusmonov, M., & Lee, I. (2010). An empirical examination of factor influencing the intension to use mobile payment. *Computers in Human Behaviours*, 26, 310-322

Kisaka, S.E., Munyi, G.M., Ndii, M., & Muio, A.K. (2015). The Relationship between Mobile Banking Deepening and Financial Performance of Commercial Banks in Kenya. *Research Journal of Finance and Accounting*. 6(10), 156 -173.

Kitchenham, B. & Brereton, P. (2013). A systematic review of systematic review process research in software engineering. Information and software technology, 55(12), 2049-2075.

Krevatin, I. (2010). Biometric recognition in telecom environment, Paper at *14th International Conference on Intelligence in Next Generation Networks (ICIN),* 1-6.

Liao, C.J., Chen, L., & Yen, D.C. (2007). Theory of planning behavior (TPB) and customer satisfaction in the continued use of e-service: An integrated model. *Computers in Human Behaviour, 23*, 2804– 2822.

Liebana-Cabanillas, F. (2012). *El papel de los sistemas de pago en los nuevos entornos electrónicos* [The role of payment systems in the new electronic environments] (Doctoral Thesis). Department of Marketing and Market Research. Universidad de Granada.

Luna, I.R. (2012). *Un estudio empírico de la aceptación de la tecnología NFC para pago móvil en España* [An empirical study of NFC technology acceptance for mobile payment in Spain] (Master's thesis). Department of Marketing and Market Research. Universidad de Granada.

Luna, I.R., Montoro-Rios, F., & Liebana-Cabanillas, F. (2016). Determinants of the intention to use NFC technology as a payment system: an acceptance model approach. *Information Systems and e-Business Management, 14*, 293–314.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Mbogo, M. (2010). The Impact of Mobile Payments on the Success and Growth of Micro-Business: The Case of M-Pesa in Kenya. *The Journal of Language, Technology & Entrepreneurship in Africa,* 2(1), 182 -203.

Montoro-Ríos, K (2017). Intention to use new mobile payment systems: a comparative analysis of SMS and NFC payments. *Economic Research*, 30(1), 892-910.

Nathaniel, K. (2015). *"Biometrics: The Future of Mobile Payments*." U.S. Economic Watch, BBVA Research.

Ndii, M.M. (2013). *The effect of mobile phone technology innovations on financial deepening within the banking industry in Kenya*. (Unpublished MBA Project). The University of Nairobi.

Pegueros, V. (2014). Security of Mobile Banking and Payments. *GIAC (GSEC) Gold Certification.* SANS Institute InfoSec Reading Room.

Pousttchi, K. & Wiedemann, D.G. (2008). *What Influences Consumers' Intention to Use Mobile Payments?* Mobile Commerce Working Group, Chair of Business Informatics and Systems Engineering, University of Augsburg, 86135 Augsburg, Germany, 1-16.

Pukkasenung, P. & Chokngamwong, R. (2016). Review and Comparison of Mobile Payment Protocol, in J.J. (Jong Hyuk) Park et al. (eds.), *Advances in Parallel and Distributed Computing and Ubiquitous Services,* Lecture Notes in Electrical Engineering, Springer, 11-20.

Rehman, K., Shafiq, H., Gruhn, T. & Volker, A. (2018). An Effective Security Requirements Engineering Framework for Cyber-Physical Systems. *Technologies,* 6, 65

Ron, D. & Shamir, A. (2013). Quantitative analysis of the full bitcoin transaction graph. In *Financial Cryptography and Data Security*, Springer Berlin Heidelberg. 6-24.

Schierz, P.G., Schilke, O. & B., & Wirtz, W. (2010). Understanding consumer acceptance of mobile payment services: An empirical analysis. *Electronic Commerce Research and Applications,* 9(3), 209-216.

Siau, K., Sheng, H., Nah, F., & Davis S. (2004). A qualitative investigation of consumer trust in mobile commerce. *International Journal of Electronic Business, 2*(3), 283-300.

Shon, T. H. & Swatman, P.M.C. (1997). Effectiveness criteria for internet payment systems. *Paper at the First Pacifica-Asia workshop on electronic commerce*, Brisbane, Australia.

Turban, E. & Brahm, J. (2000). Smart card-based electronic card payment systems in the transportation industry. *Journal of Organizational Computing and Electronic Commerce,* 10(4), 281-293.

Turban, E. (2002). *King Electronic commerce 2002: a managerial perspective*. Upper Saddle River, NJ, Pearson Education.

van der Heijden, H. (2002). Factors Affecting the Successful Introduction of Mobile Payment Systems. *15th Bled Electronic Commerce Conference e-Reality: Constructing the e-Economy* Bled, Slovenia, June 17 - 19, 430-443.

Vasileiadis, A. (2014). Security Concerns and Trust in the adoption of M-Commerce. *Social Technologies*. 2014, 4(1), 179–191.

Venkatesh, V. & Davis, F.D. (2000). Theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, 46(2), 186–204.

Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D, (2003). User Acceptance of Information Technology: Toward A Unified View. *MIS Quarterly,* 27(3), 425-478.

Weigold T. & Hiltgen, A. (2011). Secure confirmation of sensitive transaction data in modern Internet banking services, Paper at *2011 World Congress on Internet Security (WorldCIS),*125-132.

Xu, Z., Zhang, T., Zeng, Y., Wan J., & Wu, W. (2015). A Secure Mobile Payment Framework Based On Face Authentication. *Paper at Proceedings of the International Multi-Conference of Engineers and Computer Scientists 2015*, Vol I, IMECS 2015, March 18 - 20, 2015, Hong Kong.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Yang, D., Wang. Y., Ren, & Wang, J. (2010). Mobile Payment Pattern Based on Multiple Trusted Platforms – Paper at *Ninth International Conference on*, ‖ *Mobile Business and 2010 Ninth Global Mobility Roundtable (ICMB-GMR),* China*.* 353-362.

Yang, S., Lu, Y., Gupta, S., Cao, Y. & Zhang, R. (2012). Mobile payment services adoption across time: An empirical study of the effects of behavioural beliefs, social influences, and personal traits. *Computers in Human Behaviour, 28*, 129–142.

Zhou, T. (2013). An empirical examination of continuance intention of mobile payment services. *Decision Support Systems*, 54(2), 1085-1091.

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OPPORTUNITIES FOR DIGITAL TRANSFORMATION IN GOVERNMENT: A CASE OF THE NATIONAL TREASURY BUDGET PROCESS

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ABSTRACT

Aim/Purpose	This study sought to investigate opportunities for digital transformation within the National Treasury Budget Process.
Background	The study considered the impact of the Fourth Industrial Revolution (4IR), its potential impact, opportunities and challenges presented to the national budgeting process in the South African context.
Methodology	The study was conducted in the qualitative interpretive research paradigm using a case study. Data were collected from 15 stakeholders of the National Treasury Budgeting Process using structured interviews and focus groups. The data was analysed using thematic analysis with the aid of ATLAS.ti software.
Contribution	The study contributes towards understanding the impact of the 4IR on digital government in the South African context. The findings will provide policymakers with evidence that can assist them in shaping 4IR related policy.
Findings	The findings showed that there are several applicable 4IR technologies including virtual private network, blockchain technology, integrated database system and artificial intelligence but there are limited digital skills to support their implementation. Some of the other existing challenges include digital technology failures and limited resources.
Recommendations for Practitioners	It is recommend that policy makers should consider the heterogeneous future of government departments when making policy for digital technology.
Recommendations for Researchers	It is recommended that researchers of digital government should assist in the advancement of current knowledge relating to the adoption of digital technologies in the public sector and thus ensure present and future sustainability of such initiatives.
Impact on Society	The study provided theoretical arguments that establish a premise for broader societal access to 4IR information together with the opportunities and challenges it presents.
Future Research	Opportunities abound to conduct a similar a study within other divisions of the National Treasury, and other tiers (i.e. national, provincial and local) of government. This could assist in assessing the similarities and differences that exist in applicable technologies, as well as opportunities, changes and challenges presented by 4IR within the different the national departments.

Keywords	Fourth industrial revolution; Digital transformation; National Treasury; 4IR Opportunities; 4IR challenges; 4IR changes; Budget process.

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INTRODUCTION AND BACKGROUND

The world is generally undergoing a digital transformation with the manufacturing industry at the forefront through the adoption of rapidly advancing digital technologies that include artificial intelligence, cloud computing, robotics, internet of things and others. These technologies enable societal shifts by affecting the economics, values, identities and cultures of society and organisations (Herweijer, 2017). Digital technologies are making a number of decision-making process increasingly rational and less biased through data compiled over a period of time. Better and continuous improvement of organisational operations is realised by using digital technologies through the development of custom systems, the introduction of new gadgets and software updates, all of which aid in unlocking even more functionality out of any existing products and systems (Osborne and Frey, 2016). The rate of service delivery, product development, production and implementation is accelerated through the adaptation of digital technologies such as the internet of things, and software that is custom designed for organisations. Governments are changing their ways of operating to improve service delivery, to be more efficient and effective in their designs as well as to achieve goals such as increased transparency, interoperability and customer satisfaction. Government digital transformation translates to new ways of working with stakeholders, creating new service delivery frameworks and creating new forms of relationships (Kokolek *et al.*, 2019).

Digital technologies have numerous benefits such as lower costs, fast turnaround times, process efficiency consistency, less corruption, and better-quality services, all of which are key factors for the e-government's success (Luna-Reyes & Gil-Garcia, 2014). Organisations and industries need to adapt to this rapid change by adopting the requisite 4IR technologies so that they can experience exponential growth in their respective sectors (Pillay, 2019). However, low-income countries are lagging behind in digital government innovation (Schwab, 2016).

Digital transformation implies a change in the structural and operational aspects of organisations. Therefore, managers and stakeholders need clarity about the various alternatives and components they need to consider for their digital transformation efforts (Hess *et al.*, 2016). As a result, digital transformation approaches and information technology strategies must be aligned with other organisational strategies (Popova *et al.*, 2018). However, Teichert (2019) has argued that organisational culture is the number one obstacle to digital transformation. Cultural change is a requirement and can become a barrier to digital transformation if not properly managed. Centralised systems also address the many concerns over interoperability of various systems working at different levels and thus enhance the delivery of services (Verma & Dawar, 2019).

The Ministry of Higher Education and Training is now urging South African universities to promote their pedagogical practices to be aligned with the demands of 4IR; such educational initiatives will ideally lead to economic prosperity, job creation and empowerment of marginalised communities (Waghid *et al.*, 2019). At a national level, the government stands to gain from the opportunities presented by digital transformation. This research focuses attention on digital transformation within the South African government and the budget process of the National Treasury.

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PROBLEM STATEMENT AND RESEARCH OBJECTIVE

With reference to the National Treasury Budget Office of South Africa, the budget process is multifaceted with various inputs coming from all the 11 sections of the National Treasury, each with its own sub process and a means of submitting the input data. This process was introduced by the new democratic government under the presidency of Nelson Mandela following a general recognition for the need for the introduction of a more participative approach that is more closely aligned with the policy making process. The budgeting process begins with the compilation of Treasury's submission to Cabinet, which frames the government's medium-term strategic priorities. These priorities guide the decisions that need to be taken during the budget process. The next step involves the compilation of budget submissions of national departments. These submissions are drafted by the relevant spheres of government (i.e. national, provincial, local government as well as public entities) themselves and are based on frameworks put together by the Treasury. The submissions are returned to the Treasury for consideration by the Medium-Term Expenditure Committee (MTEC), which consists of members from the Presidential office and the National Treasury. This participative approach involves the sourcing of data from several sources, presentation of varied data in various formats and structure and the submission of data via various channels. The Budget Office spends time and resources coordinating data submission, integrating data, condensing all the data and ultimately producing the input for the medium-term information report that goes into the budget documentation (http://www.treasury.gov.za).

It is important to note that the Budget Office produces the guidelines on which the nation's budget is based. The National Treasury does not write the budget *per se*, it only manages the budget process. The process of formulation of medium-term information that guides the formation of the budget and the management of the approved budget relies on data collected and submitted to the Department from all the relevant spheres of government. With such vast data sources, data handling remains heavily dependent on traditional methods possessing varied formats and structures. This leads to unstructured and non-standard data handling, sorting and presentation. The output of such organisational processes is a lack of precision resulting in loss of opportunities, inaccuracies and irregularities that have proved to be costly, time-consuming and redundant. The data is mainly collected from different spheres of government in Microsoft Excel Spreadsheet format. The risks associated with Excel Spreadsheet as a method for data collection are listed below:

1. Data file is too large; this can make the Excel program run very slowly. The stakeholder's security measures may delete the Excel macros that support the template thus resulting in the template losing the desired functionality.
2. Human beings are prone to errors when using the Excel Spreadsheet. The errors are mainly corrected by developing and sending the macros or visual basic for application (VBA) code to the stakeholders. The stakeholder may run the macros in the wrong spreadsheet or security measures may delete or block the macros.
3. Inability to send the file to stakeholders when the file is too big.
4. Each time employees or stakeholders make changes manually in the Excel Spreadsheet, there is a risk of introducing errors and compromising accuracy.

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5. Budget spreadsheet requires inputs from different divisions within the organisation, and only one person can work on the spreadsheet at a time, and this can slow down the entire process (Budget Data Flow Integration Working Group, 2018).

This study therefore sought to investigate opportunities for digital transformation within the National Treasury Budget Office. Specifically, the study will: identify opportunities presented by digital technologies that are applicable to the National Treasury budget process; explore potential changes that digital transformation can introduce to the budget process; and identify challenges and opportunities digital technologies can introduce to the budget process.

LITERATURE REVIEW

In this section, the literature from different sources that define and relate to Digital Transformation and the Fourth Industrial Revolution is presented.

FOURTH INDUSTRIAL REVOLUTION

The Fourth Industrial Revolution (4IR), is the fourth major industrial era since the initial Industrial Revolution of the 18th century. The term was coined by Klaus Schwab (2016), founder and Executive Chairman of the World Economic Forum, to describe a world where individuals move between digital domains and offline reality with the use of connected technology to enable and manage their lives (Discussion Forum, 2018).

The 4IR builds on the third industrial revolution, the digital revolution since the middle of the last century. The 4IR is characterised by a combination of techniques which blur the physical, digital and biological lines (Caruso, 2018). The ordinal fourth prefix is essential because this revolution aims to drive strategic dialogue beyond the digital revolution outlined by other researchers as a shift from an industrial to an information age. The 4IR builds on the fast exchange of data made possible by the data-centred foundations of the digital technologies of the Third Industrial Revolution, which was in turn dependent on the core of the Second Industrial Revolution's electricity and telecommunications schemes (Caruso, 2018).

The merging of the real and virtual worlds and the networking within ‘internet of things, services, data and people transforms industries completely and enables much more competitiveness for organisations that operate across global and local markets (Pillay, 2019). According to the World Economic Forum, the 4IR has the capacity to increase worldwide revenue rates and enhance the quality of life for people around the globe. For example, technologies that are already being developed and applied in practice are being developed faster to unlock unprecedented potential to change the world for the better. Artificial intelligence (AI) is taking over some human functions and challenge individuals’ sense of self and agency (Discussion Forum, 2018). Robotics are making menial work obsolete, thereby improving the quality of life but also making millions of people’s jobs obsolete.

4IR AND DIGITAL INNOVATION

The 4IR is not restricted solely to manufacturing; it is a common phenomenon in all industries such as the public sector, fast-moving consumer goods, agricultural, pharmaceutical, motor industry, and it affects all areas of human existence (Park, 2018). This fusion of technologies is blending the lines among the physical, digital, and biological. It is also bringing about a shift in the way that technology, communications, data, and analytics affect the way we live, work, and relate to one another. As such, every industry is expected to be disrupted and subjected

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to continual change (Discussion Forum, 2018). Some of the prominent 4IR technologies that can be applied in the financial sector are discussed below.

Artificial Intelligence

Bishop et al. (2015) define Artificial Intelligence (AI) as computer science learning algorithms that are capable of performing tasks that normally require human intelligence and beyond, for example, visual perception, speech recognition and decision-making. AI has the ability to learn from previous situations to provide input and automate complex future decision processes, making it easier and faster to arrive at less biased conclusions (Buchanan, 2019). Artificial intelligence is based primarily on mimicking human intelligence to perform its tasks. It consists of various disciplines ranging from psychology, computing and mathematics. It has also a wide variety of applications in finance, healthcare, education, music, hospitality, and other fields (Lee *et al.*, 2018). In the budget process, AI could provide a series of guidelines based on data analysis that the Budget Office can follow to improve the budget allocation to different spheres.

Data Science

Data science is a set of fundamental principles promoting and guiding the process of information and data extraction. 4IR is characterised by rapid development, a high level of technological innovation, and a greater role in information, expertise and human factors for the development of science and technology (Bishop *et al.*, 2015). Data-science approach offers practitioners a structure and guidelines to provide the data scientist with a basis for systematic treatment of data extraction problems. Data science involves principles, processes, and techniques for understanding phenomena *via* the automated analysis of data (Provost & Fawcett, 2013). For example, employees are the most important and most critical resource that government needs to manage, often exceeding 60% of the budget information. Analytics can facilitate agencies to decide a way to deploy employees for maximum effectiveness.

Cloud Computing

Cloud computing is a computing model where a large pool of systems are connected in private and/or public networks, to provide variably sized infrastructure for application, data and file storage (Harris, 2016). Cloud computing has the following characteristics: powerful computing power and storage capacity; lower equipment requirements of the client; virtualisation and dynamic expansion; and resource sharing (Yan, 2017). With the formulation of a private cloud computing system the extensive data collected, utilised and published in the budget process can be stored in the cloud. Cloud storage will mean better security of confidential reports and data, and would also enable multiple users to access the necessary data anywhere and anytime by logging into the cloud. The budget process relies on the comparison of previous budget reports detailing the relevant resource allocation and the resultant outcomes thereof. With such a track record backed up in the cloud, the National Treasury will be able to undertake comparative analyses and ensure continuous improvement of the budget process.

Internet of Things (IoT)

IoT is a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual things are seamlessly integrated into the information network. Cyber-Physical Systems (CPS) involves a system of sensors and control elements that enable machines to be linked to plants, fleets, networks and human beings. Full traceability in any part of the value chain and live product data and customer feedback makes it possible to assure and improve overall product and

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service quality (Pillay, 2019). In the budget process, IoT can be used for data handling. The budget process involves an interaction between several stakeholders with each stakeholder producing various reports and resources that forms part of the input for the budget process.

Mobility and Mobile Applications

This refers to the incredibly rapid penetration of mobile devices and technologies in the market and the broad phenomenon of leveraging mobile solutions in the business environment. Other emerging ideas such as bringing your own device (BYOD) and choosing your own device (CYOD) can lead to changes in market practices. In business terms, ideas such as BYOD and CYOD are causing shifts in business application trends. BYOD is where people can bring their own personal devices (such as laptops, tablets and smartphones) to access corporate networks and information. CYOD is where workers pick a pre-approved computer from the organisation's list but can be used from anywhere (Al-Khouri, 2013). Mobile devices are today's government tools for communicating with those left behind in the digital divide. The South African Revenue Services (SARS) took advantage of the mobile app and introduced the e-filling mobile app, which allows the user to file the tax anywhere, anytime and is highly secure (Government Gazette, 2017).

Robotics

Robotics is the design, construction, operation, and the use of robots as well as the integration of computer systems for their control sensory feedback and information processing. Robotics are electro-mechanical, biological, and hybrid machines enabled by artificial intelligence that automate, augment, or assist human activities, autonomously or according to set instructions (Bishop *et al.*, 2015). Robotics is beginning to influence many jobs, from manufacturing to agriculture, and retail to services. According to the International Federation of Robotics, the world now includes 1.1 million working robots, and machines account for 80% of the work in manufacturing a car (Schwab, 2016). Within the budget process robotics can be applied in material handling process as they can be coded to ferry resources from one section to another and tighten security to access information without authorisation.

Cybersecurity

Cybersecurity is information technology security that focuses primarily on protecting machines, networks, software and information from unauthorised access, manipulation, damage or destruction. The role of cybersecurity is getting more and more important. The reason is that many individuals, businesses, governments and organisations store, process and keep information and data arranged in digital format for sharing purposes (Orozova *et al.,* 2019). Cyber security incidents recorded in recent years are likely to demonstrate that while policies and technology are critical components of any system of data protection, they alone cannot provide effective protection of information. Risk awareness and information security is the first line defence of security computer networks, and the personnel behaviour is critical for the protection of information handled by these networks (Ștefănescu *et al.,* 2019).

Blockchain

A blockchain is a decentralised, distributed and a public digital ledger that is used to record transactions across many devices so that any involved record cannot be changed easily, without modifying all subsequent blocks. This allows the participants to verify transactions independently (Agrawal *et al.*, 2019). Blockchain is best understood as a digital distributed ledger used to record and share information throughout a peer-to-peer network. Identical copies of the ledger are maintained and collectively validated by network members, with accepted information aggregated into blocks, which are then added to a chronological chain

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of existing, previously validated blocks, using a cryptographic signature. Among its many attributes, the technology is perhaps most remarkable for its ability to ensure digital authenticity without third-party intervention, ultimately ensuring trust through cryptographic proof in inherently trust-less environments (Antipova, 2018).

Challenges of the Fourth Industrial Revolution

The 4IR tackles and addresses some of today's world problems such as resource and energy efficiency, urban manufacturing and population change (Caruso, 2018). Organisations find digital transformation more time consuming and expensive, hence the reluctance to the 4IR concept. The first task is investment and change. Business leaders recommend changing not only suppliers and distributors, but also technology businesses and infrastructure suppliers in order to create a complicated value network (Park, 2018). Gomez *et al.* (2018) has cited five broad challenges associated with the 4IR and these are: defining a clear vision; working better together; enabling business agility; insufficient time and money; and finding flexible technology. With respect to defining a clear vision, every organisation needs to introduce operational agility to the business, anticipate and plan for higher levels of customer expectation around service, drive improvements across the internal user base and expect higher competitive threats from innovative disruptor businesses (Gomez *et al.*, 2018). These A combination of these factors formulate a clear vision within the 4IR. Similarly, Sestini (2017) has advanced that business disruption is the major challenge brought about by the 4IR since it calls for existing organisations to redefine their vision and completely restructure as they absorb new technologies as well accommodate flexibility.

The 4IR gives rise to a number of policy related ethical questions, and governments have to participate in resolving these dilemmas (Moloi, Zibani & Teane, 2018). The use of robots as nurses or companions, although it raises ethical issues, could allow substantive cost savings from replacing human labour, which conversely leads to unemployment (Osborne & Frey, 2016). Beyond practical considerations, there are important and difficult to resolve ethical issues that need to be considered (Oxford Internet Institute, 2010). The rise of robots generates several ethical considerations that range from the invasion of privacy because of the smart home. In the next section, the associated notion of digital innovation and transformation, because of the rapid changes in the 4IR, is discussed.

DIGITAL TRANSFORMATION

Digital transformation is the adaptation and use of technology to produce better activities and differentiate and radically enhance organisational efficiency. According to Hinings, Gegenhuber & Greenwood (2018), digital transformation can be described as a fundamental rethink of the use of technology to change strategy, activities and business models, and income streams. All these have important effects on clients, associates and employees. Digital transformation in distinct businesses and industries can be viewed differently because they have different digital maturity levels, stakeholders, different values and visions (Zimmermann *et al.*, 2018). Other the different types of technology, digital transformation involves changing the three key areas of an organisation, namely: operational processes; business; and customer experience. A recent study revealed that 84% of worldwide businesses view digital transformation as critical to their survival in the next five years, but only 3% of organisational transformation attempts have been completed (Chanias *et al.*, 2019). Digital transformation requires an understanding of how digital technologies can add value, disrupt industries and business models, change how consumers engage with organisations and consume products and services (Mngxati & Haas, 2019). Mngxati & Haas (2019) further espoused that digital

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transformation is a journey that requires the right levels of resource allocation. This requires the introduction of new technologies, new skills and new organisational structures to support organisational agility and embed a culture of innovation.

Challenges Associated with the Digital Transformation

Organisations in any industry are facing a variety of digital transformation deployment and management challenges. The challenges are organisational, cultural, strategic, and managerial. The management problems range from making decisions on which sections of the present business model can be stabilised if any, and which sections must be retained agile and adaptable. Digital transformation does not only deploy a sophisticated technology or an IT exercise, but also an exercise for people. This emphasizes the responsibility of human beings, organisational culture and the need for formal strategic planning in a successful digital transformation (Ebert & Duarte, 2018). Some digital innovations challenge institutional arrangements at the existing field-level more than others, having to deal with legitimacy and regulation issues. Managers often lack clarity about the various options and elements they need to consider in their digital transformation efforts. As a result, they risk not considering important elements of digital transformation or neglecting solutions that are more favourable to the specific situations of their firms, and this could have unintended adverse effects (Hinings *et al.*, 2018)

Moloi, Zibani & Teane (2018) have argued that more still needs to be done in the areas of e-participation, accountability and the development of digital government. The public sector faces the same challenges as the private sector, such as the lack of an adequate skills pool to develop digital government services and solutions, and a dearth of skills within organisations. There is also a challenge of infrastructure and access to services; one of the main barriers is the cost of access to these services. Mngxati & Haas (2019) have indicated that the primary factors hindering the efficient rollout of digital government plans are partially due to the inconsistent implementation and view of technology development across municipal governments and departments. Cost is another hindrance, since the national budget does not allow for expensive technologies required to reach e-government objectives. A larger portion of the budget needs to be allocated to information and communications technology (ICT) spend, as there are significant socio-economic benefits that can be derived (Moloi *et al.*, 2018).

METHODOLOGICAL APPROACH

This study has adopted a qualitative method of research. It utilised primary data gathered through interviews and focus groups from the National Treasury and relevant stakeholders. The research followed an interpretivist philosophy and utilised an inductive approach. The approach aided in compiling opinions from the various participants to draw patterns from the responses thereby answering the research questions. The study sought to investigate opportunities for digital transformation within the National Treasury Budget Office. The budget process involves different processes and different stakeholders. It is important to understand stakeholder's processes of the Budget Office and their challenges to be able to integrate the system. In order to achieve the research objectives, the aforementioned approach was adopted since it considers the necessity to understand the differences between people in society and to understand the world from the point of view of those involved in the process (Goldkuhl, 2012).

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To achieve the purpose, the study was designed along the dictates of a mono-qualitative interpretive research. A case study approach was followed inductively. The study was conducted in the qualitative interpretive research paradigm using a case study. Data was collected from 15 stakeholders of the National Treasury Budget Office using structured interviews and focus groups. The data collected through in-depth interviews of the stakeholders was transcribed using Microsoft Word and analysed using ATLAS.ti version 8.4 software. The data analysis of the thematic framework using ATLAS.ti was done in three phases, namely: (i) constant comparison and open coding; (ii) core category and selective coding; and (iii) building new theory. A summary of the National Treasury Department's divisions including their mandates are outlined in Table 1.

Table 1: Mandates of the divisions of the National Treasury Department

National Treasury Divisions	Mandate
Assets and Liability Management	Manages government's assets and liabilities.
Budget Office	Coordinates the national budgeting process.
Corporate Service	Responsible for the department's governance framework.
Economic Policy	Provides policy advice on macroeconomic developments, international economic developments and microeconomic issues.
Tax and Finance Sector Policy	Responsible for advising the Minister of Finance on tax policy. The Financial Sector Policy unit is responsible for the design and legislative framework of the financial sector.
International and Regional Economic Policy	Promotes international, regional and African growth and development.
Intergovernmental Relations	Coordinate fiscal relations between national, provincial and local government.
Office of the Accountant General	Sets government accounting policies and practices.
Public Finance	Assesses budget proposals and reviewing service delivery trends in national government departments and their entities.
Office of the Chief Procurement Officer	Modernise the state procurement system to be fair, equitable, transparent, competitive and cost-effective.

FINDINGS AND DISCUSSIONS

RESPONDENTS' PROFILES

As already mentioned, the data was collected through interviews and focus groups. The respondents were requested to answer 13 structured questions in face-to-face interviews. The e-mail requesting the respondent to participate in the research interviews was sent to 200 internal stakeholders and 17 National Treasury external stakeholders. The divisions of the National Treasury that were targeted for this research study are: Budget Office, Public Finance and ICT (falls under Corporate Services division). The clients targeted for this research study were composed of individuals from South African Reserve Bank, national departments and public entities. A total of 15 interviews were conducted with 10 individuals and 5 focus groups.

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The sizes of the focus group ranged from 2 to 5 individuals. The data below represents the respondents' overview. The data acquired from the respondents is summarised in Table 2.

Table 2: An overview of the responses of the respondents

Respondent group	Respondent	No of respondent per group	Division: Chief Directorate	Position
Focus group	1	2	Budget Office: Expenditure Planning	Director, Deputy director
Focus group	2	2	Budget Office: Public Finance Statistics	Deputy director, Intern
Focus group	3	5	Budget Office: Public Finance Statistics	Director, Deputy director, Assistance director
Individual	4	1	Public Finance: Justice and Protection Service	Director
Individual	5	1	South Africa Reserve Bank	Economist (National Account)
Individual	6	1	Corporate Services: ICT	Deputy director (Data Administrator)
Individual	7	1	Budget Office: Public Service Remuneration	Director
Individual	8	1	Budget Office: Fiscal Policy	Director
Focus group	9	3	Public Finance: Urban and Infrastructure, Economic Service, Central Government	Director, Deputy director
Focus group	10	3	Budget Office: Public Finance Statistics	Director, Deputy director
Individual	11	1	Budget Office: Public Finance Statistics	Chief Director
Individual	12	1	Corporate Service: ICT	Director (Enterprise Architecture and Acquisition
Individual	13	1	Corporate Service: ICT	Director (Service level manager)
Individual	14	1	Corporate Service: ICT	Deputy director (Network and infrastructure)
Individual	15	1	Consultant	Technical Advisor (Data System)

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SUMMARY OF RESULTS

The findings emanating from this research study and a summary of the results are shown in Figure 1.

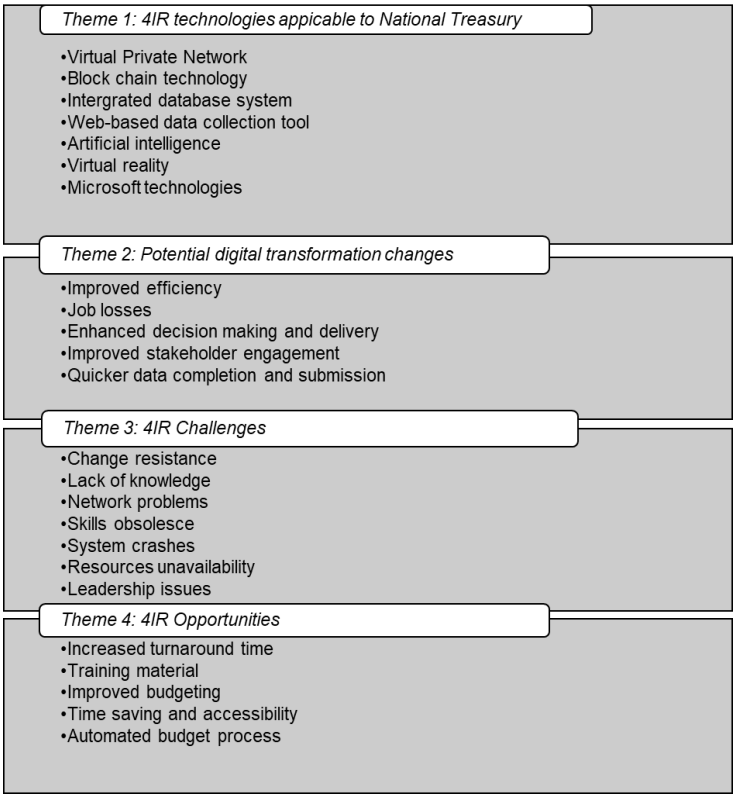

Figure 1: Core categories and themes

4IR TECHNOLOGIES APPLICABLE TO THE NATIONAL TREASURY DEPARTMENT

The 4IR technologies applicable to the National Treasury budget process, which were established by this study, are explained in this section.

OVERVIEW OF SMART LIBRARY TECHNOLOGIES

Virtual Private Network

Palojarvi, Savolainen and Kettunen (2019) posited that Virtual Private Networks (VPNs) allow easier accessibility while upholding confidentiality. This study focused on understanding the 4IR technologies that are applicable to the National Treasury. VPN was found to be one of the technologies that are being utilised by few employees in the Department. The findings suggest that VPNs need to be extended to all employees for easy access and convenience. In agreement with work reported by Palojarvi, Savolainen & Kettunen (2019), it was found in this study that VPN is being used as it allows employees to work from any location provided they have access to the requisite devices such as laptop or table. This technology allows easy access and quicker decision making as employees can access the treasury portal irrespective of their location. This can in turn provide a foundation for improved budgeting.

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Block Chain Technology

Liu & He (2019) have conjectured that block chain technology is a decentralised data storage technology, provides a traceable path of data, and establishes a trusted data assets trading environment. In agreement with results published by Liu and He (2019), this study has found that block chain technology was another technology that can be employed by National Treasury budgeting process. The findings suggest that block chain technology is where the Department is headed where the public can easily access the relevant information that affect them directly. This can also be a platform for providing feedback from the public. The access to information and allowance for feedback can ultimately result in improved budgeting by the National Treasury due to input from a wider range of stakeholder.

Integrated Database System

Gcora & Chigona (2019) have postulated that good financial management system is a vital aspect for the public sector because it can allow for an accurate and detailed assessment of the impacts of policy decisions. Furthermore, good financial management system assists in the planning and allocation of internal resources, budgeting, monitoring and accountability. This study found that an integrated database is another technology that can be utilised by the National Treasury Department. The budget process involves different data from various stakeholders. This implies that processes being integrated to ensure that the collection tools meet the standard set. The integrated database will enable the centralised sourcing and storage of data.

Web based Collection Tool

Web-based data collection tool was found to be another technological tool that can be utilised by the National Treasury Department. The web-based data collection was focused on the premise that the various stakeholders of the National Treasury Department capture the information and submit it to the Department online, and the data can be extracted. This implies that the data will be extracted from the stakeholders on the web, and this may lead to an improvement in the budgeting process of the Department. Corroborating results generated by Skarupova (2014), this study found that web-based data collection tool allows access to diverse information and information is key to sound and proactive decision making.

Artificial Intelligence (AI)

This study found that AI is another technology that can be utilised by the National Treasury Department. AI is applicable where the machine can be taught to do work in an integrative manner, and can enable the paradigm shift from the traditional Excel Spreadsheet reliance to more effective and efficient technologies. This means that AI is another technology that can be adopted by the National Treasury Department. The findings of this study are aligned with those of Buchanan (2019), which elucidated that AI can aggregate data from previous situations to provide input and automate complex future decision processes, thus making it easier and faster to arrive at less biased conclusions.

Virtual Reality

Virtual reality was found to be another technology that could be utilised for the National Treasury budget process. The respondents explicated that the use of virtual reality allows the pseudo presence of a certain person in a different geographical location. Virtual reality can allow easier communication and pseudo presence of the relevant individual, for example a Minister, presenting budget speed in parliament. These study findings validate postulations by Baccon, Chiarovano & MacDougall (2019), which proclaim that virtual reality allows easy access to face-to-face communication with anonymity being guaranteed.

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Microsoft Technologies

In this research, Microsoft technologies, such as Microsoft SQL management server studio, Microsoft Power Business Intelligence (BI), SharePoint and Microsoft Office, were identified as one of the technologies that were being used in the National Treasury budget process. This implies that these Microsoft technologies are contributing towards efficiency and effectiveness in the budget process. The ultimate result that is yielded from the adoption of such technologies may entail improved budgeting process. These study findings are in agreement those of Garrott et al. (2019), which suggest that the Business Intelligence phenomenon emerged when the increased amount of unstructured data from multiple sources leads to ETL (Extraction, Transformation and Loading) data warehouses, data mining, and data operations enabling business professionals to analyse large databases for strategic planning purposes.

POTENTIAL DIGITAL TRANSFORMATION CHANGES

The researcher also focused on trying to understand the changes that digital transformation can bring to the National Treasury budget process. The findings are discussed in the sub-sections that follows.

Improved Efficiency

With regards to the potential changes that the digital transformation can bring in the National Treasury budget process, improved efficiency was noted to be a resultant factor. The respondents posited that the adoption of digital technologies, or digital transformation, efficiency is improved in terms of processes, time and cost. Karjalainen, Heinonen & Shaw (2019) have elucidated that 4IR technologies improve efficiency in the business arena, and this aligns with the findings of this study. The respondents indicated that the digitalisation of the budget process will result in an efficient budgeting system. Client satisfaction was also found to be a resultant benefit of improved efficiency.

Job Losses

Fink & Elisabetta (2019) have argued that the future of 4IR is associated with massive job losses and obsolescence of certain skills. In this study, it was found that job losses is another potential change that digital transformation poses on the National Treasury, and this concurs with the findings of Fink & Elisabetta (2019). The digital transformation ultimately leads to retrenchment and job losses, despite bringing a plethora of benefits to the Department. This means that digital transformation results in a transformational shift from a labour intensive labour force to capital or digital intensive economy. Such a shift results in the employees losing their jobs; therefore, job losses is another change that digital transformation will bring to the department.

Enhanced Decision Making and Delivery

In this study, it was found that digital transformation give rise to enhanced decision making and delivery. The respondents' overture that, through digital transformation, sound decision making is enhanced as digitalisation allows for easier and much more efficient collaboration, which ultimately leads to enhanced decision making. Digital transformation also enables enhanced delivery as digital transformation initiatives reduce the delivery time to the relevant stakeholders. This means that digital transformation provides a firm foundation for enhanced decision making and delivery.

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Improved Stakeholder Engagement

Improvement stakeholder engagement was found to be another potential change that digital transformation can bring on the National Treasury budget process. Digital transformation provides a premise for improved stakeholder engagements through digitalised efforts thereby making stakeholder engagement easier. The respondents indicated that through digitalised initiatives, there is easier integration and improved stakeholder relationships. It was also found that, through digital transformation, there will be quicker feedback platform that translates to improved premise for engagement. Ultimately, this means that digital transformation provides for improved stakeholder engagement.

Quicker Data Collection and Submission

The findings revealed that, through digital transformation technologies, quicker data collection and submission is enabled. The study found that web-based technologies provide flexibility to stakeholders as they will be able to work anywhere and anytime. Multiple people will be able to work on one tool at the same time through such technologies. This implies that digital transformation provides for quicker data completion and submission to the National Treasury Budget Office.

FOURTH INDUSTRIAL REVOLUTION CHALLENGES TO BUDGET PROCESSES

The next section outlines challenges that 4IR presents to the National Treasury budget process. Annexure A displays the 4IR challenges. Challenges emanating from 4IR that are faced by the Department are discussed in the sub-section that follows.

Change Resistance

As with most organisations and personnel, any change is often accompanied by resistance. The respondents in this study indicated that the major challenge faced by most of the individuals, especially those with the relevant authority, are resistance to the adoption of the 4IR initiatives. The findings showed that that most of the personnel in the Department seem to be technophobic. This resistance to change acts as a barrier to the adoption of the relevant technologies since the employees are not willing to adapt to new and revolutionary technological advancements.

Lack of Knowledge

This study found that lack of knowledge on 4IR presents another challenge to the National Treasury budget process. It is imperative to note that any changes in technology demand another dimension of knowledge that is relevant to the adopted technology. However, this is not always the case, a mismatch between the adopted technology and the required skills or knowledge is often found. This means that not all of the personnel that are acquainted with the 4IR concept and ultimately the requirements that it demands. Lack of knowledge on the systems or technologies may ultimately lead to bottlenecks in the budgeting process.

Network Problems

Network problems associated with 4IR poses challenge to the budget process of the National Treasury. The participants professed that the 4IR initiatives are highly dependent on the network. At times this network will be down, and this means that the whole system will not be functioning. The network downturn results in reduced productivity, which is detrimental to the overall budgeting process. The network problems (network is a component of 4IR) are another challenge that this study found to be affecting the budgeting process.

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Skills obsolescence

4IR related skills obsolescence was found to be another challenge that 4IR presents to the National Treasury budget process. Keeping up with the changes and demands of 4IR is not easy in terms of skills and knowledge. Continuous evolution of the industrial revolution also results in the continuous development of skills required by the new technologies. This implies that that there is a close relationship between technology and skills. Such reciprocity results in some of the skills being possessed by the personnel in the Department having to be obsolete. This also calls for re-training of the employees and any continuous changes in technology will thus impede the budgeting process.

System Crash

The modern technologies also present some demerits compared to the traditional methods (manual processes). This study found that system crash is another challenge associated 4IR that poses a risk to the budget process of the National Treasury Department. While there is room to improvise with manual methods, the same cannot be said for modern systems. This means that the modern systems are prone to crashing and when this happens during the budgeting processes, and this poses serious risks to the delivery of budgets. This means that system crash is a challenge that is associated with 4IR that poses serious to the budget process.

Resources Unavailability

The findings of this research suggest that the unavailability of resources is a potential challenge to the budget processes. The results show that the Department is under resourced in terms of human resources and this results in increased workload, which in turn results in reduced productivity in the Department. The respondents also admitted that there are facing financial inadequacies that is detrimental to the acquisition and implementation of the latest 4IR technologies.

Leadership Issues

Leadership issues were noted to be another challenge that impedes the adoption of 4IR technologies in the Department. The respondents extended that the older members of senior leadership or management that have been running the Department for a long time are reluctant to embrace 4IR. The results have shown that the senior management is acting as a barrier towards effective adoption and implementation of 4IR for the budget process.

FOURTH INDUSTRIAL REVOLUTION OPPORTUNITIES IN THE BUDGET PROCESS

This section is focussed on perceptions on opportunities that 4IR presents for the National Treasury budget process. Annexure B displays the 4IR opportunities. The followed opportunities were established by the studies: increased turnaround time; training material; time saving and accessibility; automated framework; and improved budgeting. These sub-themes are discussed in the sub-sections that follows:

Increased Turnaround Time

The study has demonstrated increased turnaround time an opportunity being presented by 4IR for the budget process. The respondents indicated that through 4IR initiatives, faster and efficient transactions are realised. This means that the budget process team will be able to achieve much quicker responses to data request and queries. This study found that the 4IR provides a platform for efficiency and quicker turnaround times.

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Training Material

Training material was found to be another opportunity that 4IR presents to the budget process of the National Treasury Department. The respondents professed that the training material will be comprise of web-based training and video or audio training that will be accessed by the trainees at any given time or location. This material will provide readily available information that the personnel can use during the training or as reference during the budget process. This can also be used as a strategy to combating training absenteeism since the employees or stakeholders would be able to access the training material at any given time. This method is also cost efficient and an effective training method. This means that the training material is one of the opportunities that the 4IR presents to the budget process.

Improved Budgeting

This study has also established that improved budgeting is another opportunity that 4IR presents to the budget process. The respondents indicated that the technology will reduce employee stress and frustration during the budget process as compared to when the manual process is used. This means that the adoption of the 4IR technologies provides a premise for the improvement of the overall budget process. This implies that the adoption of technology provides for an easier way of doing things that ultimately improves the budget process.

Time Saving and Accessibility

Time saving and accessibility was noted as an opportunities being presented by 4IR presents for the National Treasury budgeting process. The findings showed that the use of web-based and integrative systems saves time and reduces duplication. These approaches will also be accessible to diverse stakeholders. This implies that time saving and easier accessibility are some of the opportunities that the 4IR presents to the budget process.

Automated Framework

An automated framework was noted as an opportunity presented by 4IR for the budget process. The respondents indicated that for an easier and efficient budget process, there should be an accessible and automated framework. It is claimed that the adoption of digital technology results in an accurate automated framework for budgeting. This means that the adoption of the automated framework can result in the improvement of the budget system. This implies that automated framework system is another opportunity that 4IR presents to the National Treasury budget process.

CONCLUSION

This study investigated and identified 4IR technologies that are applicable to the improvement of the National Treasury budgeting process. The results of the study showed that virtual private network, block chain technology, virtual reality, integrated database system, artificial intelligence, web-based data collection tool and Microsoft technologies are the key 4IR technologies for National Treasury. This study also identified changes that digital transformation can bring to the National Treasury budget process. The most common changes are: improved efficiency; improved stakeholder engagement; enhanced decision making and delivery; job losses; and quicker data collection and submission. However, the study has also identified various challenges associated with 4IR that pose a risk to the National Treasury budget process. Amongst these, the more recurrent challenges are: change resistance; skills obsolescence; system crash; lack of knowledge; resources unavailability; and leadership issues. Furthermore, a plethora of opportunities abound that 4IR technologies present to the

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budget process of the National Treasury Department. These include: increased turnaround time; training material; time saving and accessibility; automated framework; and improved budgeting.

Results emanating from this research study will contribute towards making other researchers to fully understand the opportunities, changes and challenges that 4IR presents to the National Treasury budget process; in this regard, the study will provide researchers with access to the requisite data. The possibility exists of duplicating a similar study at other divisions of the National Treasury Department. Such an undertaking could assist in assessing the similarities and differences in applicable technologies, opportunities, changes and challenges presented by 4IR in the different division.

The scope of the study was restricted to the National Treasury Department of South Africa, and therefore findings are not generalizable to other national departments of the South African government, the rest of the African continent, other developing countries and emerging economies. Furthermore, technological systems are prone to rapid changes and there is therefore a greater possibility that the study might become irrelevant or less relevant in the near future.

Lastly, the research was time-bound, hence it is inevitable that it was impacted by time afforded to undertake and complete the research. It is anticipated that future research can be conducted to investigate applicable technologies, opportunities, changes and challenges that are presented by 4IR in other national government departments and the private sector.

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REFERENCES

Agrawal, U., Koshy, I., & Churi, P. P. (2019, March). A Role of Blockchain in IoT and Financial Applications. In *2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN)* (pp. 1-7). IEEE.

Al-Khouri, A. M. (2013) 'Technological and Mobility Trends in E-Government', *Business and Management Research*. Sciedu Press, 2(3). doi: 10.5430/bmr.v2n3p90.

Antipova, T. (2018) *Using Blockchain Technology for Government Auditing*.

Budget Data Flow Integration Working Group (2018) *BDI Recommendations.*

Baccon, L. A., Chiarovano, E., & MacDougall, H. G. (2019). Virtual Reality for Teletherapy: Avatars May Combine the Benefits of Face-to-Face Communication with the Anonymity of Online Text-Based Communication. *Cyberpsychology, Behavior, and Social Networking*, *22*(2), 158-165.

Bishop, B. Pearson, R., Youngblood, R., & Jordow, N. (2015) 'Leading from the front: Redesigning finance for the digital age', pp. 3–15.

Buchanan, B. G. (2019) *Artificial intelligence in Finance*. Washington.

Cabañeros, A., & Angulo Bahón, C. (2019, October). A Comparison of autonomous vehicle navigation simulators under regulatory and reinforcement learning constraints. In *Artificial Intelligence Research and Development: Proceedings of the 22nd International Conference of the Catalan Association for Artificial Intelligence* (Vol. 319, p. 115). IOS Press.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Caruso, L. (2018) 'Digital innovation and the fourth industrial revolution: epochal social changes?', *AI and Society*. Springer London, 33(3), pp. 379–392. doi: 10.1007/s00146-017-0736-1.

Chanias, S., Myers, M. D. and Hess, T. (2019) 'Digital transformation strategy making in pre-digital organizations: The case of a financial services provider', *Journal of Strategic Information Systems*. Elsevier B.V., 28(1), pp. 17–33. doi: 10.1016/j.jsis.2018.11.003.

Discussion Forum (2018) 'Discussion Forum: The 4th Industrial Revolution', (September), pp. 11–13.

Ebert, C. and Duarte, C. H. C. (2018) 'Digital Transformation', *IEEE Software*. IEEE Computer Society, 35(4), pp. 16– 21. doi: 10.1109/MS.2018.2801537.

Fink, A., & Elisabetta, E. (2019). Skill flows and the Fourth Industrial Revolution: future questions and directions for the ASEAN Economic Community. In *Skilled Labour Mobility and Migration*. Edward Elgar Publishing.

Garrott, J., Negreiros, M., Alexandre, J., & Marques, L. (2019). *Microsoft Power BI Desktop for Data Analytics.* Proceedings of the Multidisciplinary Academic Conference; 2019, p132-149, 18p

Gomez, G. Solis, B. Sanchez J. (2018) *Top 5 Challenges of Digital Transformation*. Retrieved September 9, 2019 from https://www.bankingtech.com/files/2017/08/Top_5_Challenges_of_Digital_Transformation.pdf

Gcora, N., & Chigona, W. (2019, 11 20). Post-implementation evaluation and challenges of Integrated Financial Management Information Systems for municipalities in South Africa. *SA Journal of Information Management, 21*(1).

Herweijer, C. (2017) 'Harnessing the 4th Industrial Revolution for Sustainable Emerging Cities', *Fourth Industrial Revolution for the Earth*, 2(November), pp. 7–19.

Hess, T., Matt, C., Benlian, A., & Wiesböck, F. (2016). Options for formulating a digital transformation strategy. MIS Quarterly Executive, 15(2).

Hinings, B., Gegenhuber, T. and Greenwood, R. (2018) 'Digital innovation and transformation: An institutional perspective', *Information and Organization*. Elsevier Ltd, 28(1), pp. 52–61. doi: 10.1016/j.infoandorg.2018.02.004.

Harris, T. (2016) *Cloud Computing – An Overview*. Retrieved October 30, 2019 from https://www.torryharris.com/downloads/Cloud-Computing-Overview.pdf

Karjalainen, J., Heinonen, S., & Shaw, M. (2019). Peer-to-peer and circular economy principles in the fourth industrial revolution (4IR)–new risks and opportunities. In *2019 International Conference on the Domestic Use of Energy (DUE)* (pp. 220-230). IEEE. Kokolek, N., Jakovic, B., & Curlin, T. (2019). Digital knowledge and skills – key factors for digital transformation. *Annals of DAAAM and Proceedings of the International DAAAM Symposium. 30*, pp. 46-53. Danube Adria Association for Automation and Manufacturing, DAAAMa

Lee M, Yun JJ, Pyka A, Won D, Kodama F, Schiuma G, Park H, Jeon J, Park K, Jung K, Yan MR. (2018) 'How to Respond to the Fourth Industrial Revolution, or the Second Information Technology Revolution? Dynamic New Combinations between Technology, Market, and Society through Open Innovation', Journal of Open Innovation, 4(21), pp. 3–20. doi: 10.3390/joitmc4030021.

Luna-Reyes, L., & Gil-Garcia, J. (2014). Digital government transformation and internet portals: The co-evolution of technology, organizations, and institutions. *Government Information Quarterly, 31*(4), 545-555.

Mahdavinejad, M. S., Rezvan, M., Barekatain, M., Adibi, P., Barnaghi, P., & Sheth, A. P. (2018). Machine learning for Internet of Things data analysis: A survey. Digital Communications and Networks, 4(3), 161-175..

Mngxati, V. and Haas, J. De (2019) *Unlocking Digital Value for Business and Society in South Africa*. Accenture. Retrieved December 24, 2019 From https://www.accenture.com/_acnmedia/PDF-

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

118/Accenture-Unlocking-Digital-Value-For-Business-And-Society-In-South-Africa.pdf#zoom=50

Moloi, D., Zibani, S. and Teane, L. (2018) 'Fourth industrial revolution and the future of government', *Service Delivery Review*, 11(3), pp. 2–34.

National Treasury South Africa. (2015). *Strategic plan, 2015/19.* Retrieved September 5, 2019 from http://www.treasury.gov.za/publications/strategic%20plan/default.aspx

Orozova, D., Kaloyanova, K., & Todorova, M. (2019). Introducing Information Security Concepts and Standards in Higher Education. *TEM Journal*, *8*(3), 1017.

Osborne, M. A. and Frey, C. B. (2016) 'The Impacts of the Fourth Industrial Revolution on Jobs and the Future of the Third Sector', pp. 1–25.

Oxford Internet Institute. (2010) *Technological, Social and Economic aspects of FI*. Retrieved June 3, 2019 from http://cordis.europa.eu/fp7/ict/fire/docs/tafi-final-report_en.pdf -

Park, S. C. (2018) 'The Fourth Industrial Revolution and implications for innovative cluster policies', *AI and Society*. Springer London, 33(3), pp. 433–445. doi: 10.1007/s00146-017-0777-5.

Pillay, K.., Ori, A. & Merkofer, (2017b). Industry 4.0: Is Africa Ready for Digital Transformation*? A Case Study of Deloitte South Africa - White Paper Report.*

Palojarvi, J., Savolainen, J. P., & Kettunen, M. T. (2019). *U.S. Patent No. 10,375,023*. Washington, DC: U.S. Patent and Trademark Office. Popova, I., Ivory, C., & Uhlin, A. (2018). *Organisational Approach to Government Digital Transformation: Comparing the UK and Sweden* Schwab, K. (2016) *The Fourth Industrial Revolution*. 1st edn. Geneva.

Sharma, A. (2012). Global climate change: What has science education got to do with it? *Science & Education*, *21*(1), 3353.

Skarupova, K. (2014). Computer-assisted and online data collection in general population surveys'. *European Monitoring Centre for Drugs and Drug Addiction, Lisbon*.

Sofie, C., Haukeberg, L. &po Fosshode, T. (2016) *Adopting Robotics in Downstream Financial Services*. Bergen.

Sestini, F. (2017) *The Digital Transformation: Trends and Challenges for Governance of Human Societies*. European commission. Retrieve November 30, 2019 from https://ec.europa.eu/jrc/communities/sites/jrccties/files/02_sestrini.pdf

Ștefănescu, C., Elena Comănescu, L., Buhuși, C., Adrian Bîlcan, G., & University, V. (2019). Cyber security for Cyber accounting-Tool for the Digital Enterprise. Academic Journal of Economic Studies, 5(3), 138-143.

Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 67*(6), 1673-1687.

Verma, N., & Dawar, S. (2019, 11 1). Digital transformation in the Indian government. *Communications of the ACM, 62*(11), 50-53.

Waghid, Y., Waghid, Z., & Waghid, F. (2019, 12). The fourth industrial revolution reconsidered: On advancing cosmopolitan education. *South African Journal of Higher Education, 33*(06).

Yan, G. (2017) 'Application of Cloud Computing in Banking : Advantages and Challenges', *Cloud Computing*, 23(Icpel), pp. 29–32.

Zimmermann, A., Schmidt, R., Sandkuhl, K., Jugel, D., Bogner, J., & Möhring, M. (2018, October). Evolution of enterprise architecture for digital transformation. In 2018 IEEE 22nd International Enterprise Distributed Object Computing Workshop (EDOCW) (pp. 87-96). IEEE.

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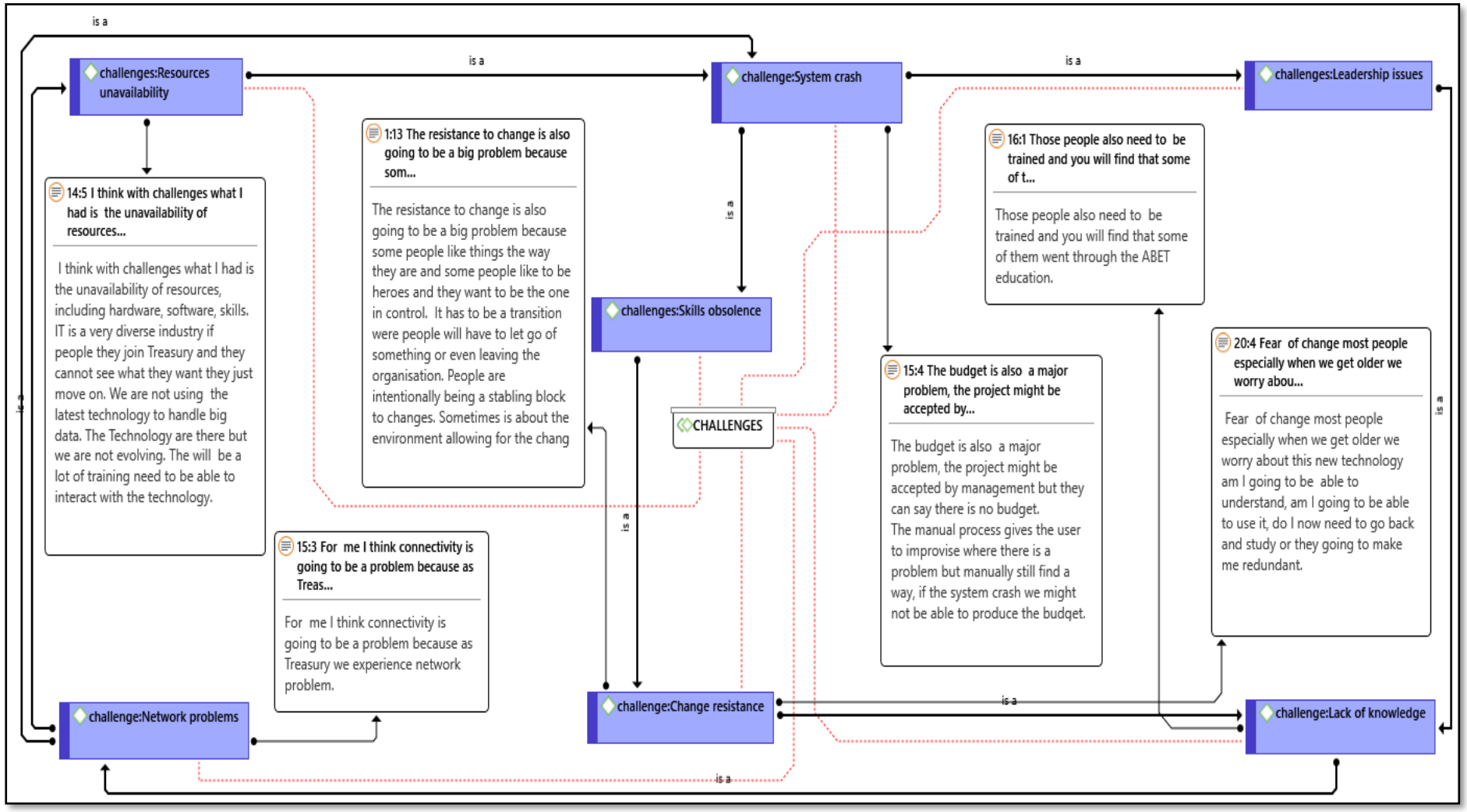
Annexure A: IR Challenges



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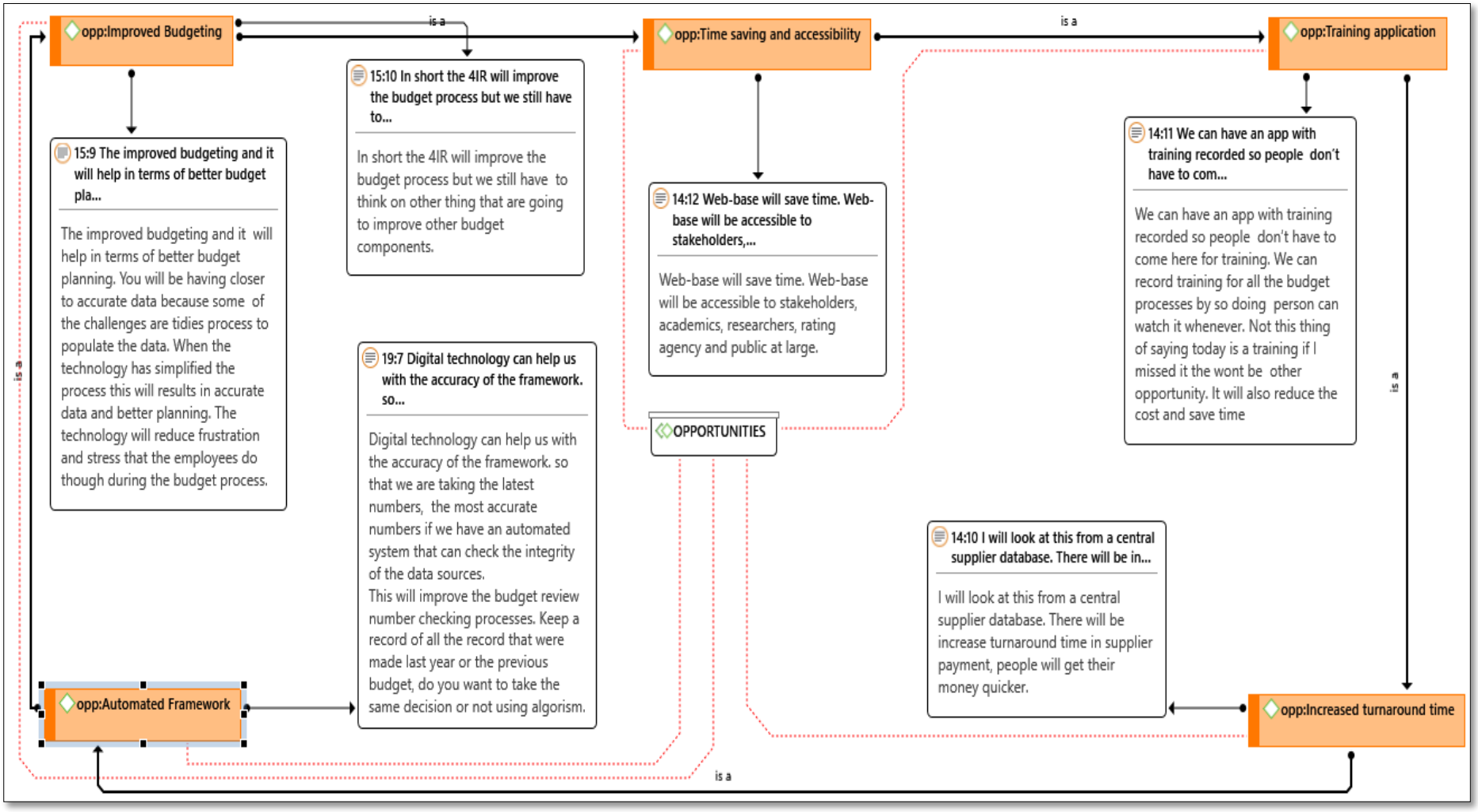
Annexure B: IR Opportunities



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USING MACHINE LEARNING ALGORITHMS AND DATA MINING TOOLS TO DIAGNOSE HEART DISEASES FOR ELDERLY PATIENTS

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ABSTRACT

Aim/Purpose	The aim of this research paper is to apply Naïve Bayes, K-Nearest Neighbor, Support vector machine, J48 and Random forest data mining techniques on a WEKA data mining tool in order to monitor and predict heart-related diseases and detect early vital signs.
Background	Heart disease is amongst the major causes of death throughout the world for the past decade. Diabetics, blood pressure and cholesterol levels are amongst the main contributing factors for heart-related diseases.
Methodology	This paper has applied a data mining tool, WEKA, and machine learning techniques to accurately predict heart disease.
Contribution	This paper contributes to the Smart health domain in assisting to predict heart-related diseases before they cause any serious harm, for example, stroke, angina and hypertension.
Findings	A comparison of results obtained using Naïve Bayes, K-Nearest Neighbor, Support Vector, J48 and Random Forest Algorithms. Support Vector Machine achieved the highest accuracy with lower error on training. The Support Vector Machine algorithm had the overall best performance.
Recommendations for Practitioners	Adoption of the Support Vector Machine algorithm to accurately predict heart-related diseases.
Recommendation Research for Researchers	Continued research in order to carry out more tests using different datasets, data mining tools and machine learning algorithms.
Impact on Society	These findings will improve on the way that heart disease predictions have been done in the past.
Future Research	This will involve using digital skills, machine learning, data science and Internet of Things (IoT) to further enhance heart disease predictions.

Keywords	Heart Diseases; Data Mining Techniques; Machine Learning; Algorithms and ThingWorx; K-Nearest-Neighbor (KNN); Naïve Bayes and Support Vector Machine.

INTRODUCTION

Heart disease is amongst the major causes of death throughout the world for the past decade (Public & Security, 2007). Diabetics, blood pressure and cholesterol levels are amongst the main contributing factors for heart-related diseases. Some of the risk factors associated with heart diseases can be traced back to family medical history, smoking and drinking patterns of

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the patient as well as poor diet. If heart disease vital signs are not properly detected, monitored and contained at an early stage, they can lead to critical health conditions such as heart attack, stroke and angina.

A number of data mining techniques such as Decision Tree, Neural Network, Naïve Bayes and K-Nearest Neighbor (K-NN) algorithms are being used to predict and detect heart disease risks and critical vital signs. Furthermore, the exploitation of data mining techniques in order to assist medical care practitioners to diagnose early signs of heart disease is motivated by the worldwide growth in the number of yearly heart disease-related mortality rate and the availability of patients' datasets extracted from various healthcare centers (Helma, Gottmann & Kramer, 2000). Heart disease prediction and detection systems can help healthcare professionals in the detection and prediction of heart diseases based on clinical patient data. In this research paper, a supervised machine teaching Naïve Bayes, K-NN and Forest Random algorithms together with a WEKA tool are proposed for the implementation of heart disease detection, prediction and a monitoring system that will attempt to accurately validate dataset from a Cleveland Open Source. The second contribution in this research paper is the representation of heart disease vital signs monitoring systems that use the Internet of Things (IoT) concept through a sensor, gateway and an Arduino micro-controller. Different medical sensors are been used in the IoT and related technologies in order to collect, analyze and push forward relevant medical information from one node to the other. The Thingworx platform can accommodate a huge number of sensor datasets coming from heterogeneous devices trying to access the ThingWorx server for informed and accurate patient data.

HEART DISEASES AND RISK FACTORS

Heart Disease

A heart is a very sensitive part of a human body which ought to be consciously guided by health and medical experts (Public & Security, 2007). Heart disease can be defined as any kind of discomfort affecting the normal function of the heart. Heart diseases normally occurs whenever arteries that provide oxygen to the heart via blood circulation or blood flow, completely gets blocked or becomes narrowed (Lateef et al., 2006). Heart based diseases can be classified in to 4 different categories, that is:

Heart Attack: A heart attack is a result of significantly reduced or no blood flow into the heart. It normally happens when one or more coronary arteries which carry the blood to the heart gets blocked. This might lead to heart muscles getting damaged.

Heart Failure: This occurs when the heart cannot pump enough supply of blood to various parts of the body. This condition does not automatically mean that the heart has seized to function.

Angina: This occurs when there is no adequate blood flow into the heart. It is regarded as one of the symptoms related to coronary artery disease with symptoms such as pain in the chest, jaw and shoulders.

Arrhythmias: This is how fast or slow the heart beats. It is normally referred to as the irregular manner at which the heart beats per second.

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RISK FACTORS CONTRIBUTING TO HEART DISEASES

Conditions or habits where an individual is more likely to develop heart related diseases are determined by certain risk factors, which also contribute to the probability of an existing disease escalating to a worse state (Manivannan et al., 2016).

Controllable Risks

Smoking: Traces of chemicals found in tobacco contribute to the development of blood clots which ultimately increases the risk of heart attack due to plaque build-up inside artery walls (Yanwei et al., 2007).

Weight: For every kilogram the body gains, the higher the risk of contracting the diseases. This is medically proven for individuals who carry an extra amount of fat around their waist (Palaniappan & Awang, 2008)

Cholesterol: If blood has a lot of cholesterol and it builds up on the artery walls, this can result in a condition called atherosclerosis (Guru et al., 2007).

Diabetics: Sugar diabetes, if not properly managed can create some injury and damage on the artery walls and that eventually causes blood clots (Lee et al., 2007).

Blood pressure: When one's heart beats, it pumps blood around his/her body to give it the energy and oxygen it needs. As the blood moves, it pushes against the sides of the blood vessels. The strength of this pushing is your blood pressure (Singh & Chauhan, 2009).

Uncontrollable Risk Factors

Age: Most heart-related diseases are common amongst women as they enter menopause and men that have passed the age of 40. The majority of individuals that have died from heart related diseases such as heart attacks are usually above the age of 65 (Noh et al., 2006).

Sex: Medical studies are of the opinion that men have a higher risk of heart attack than women and that most men generally experience heart attack at early years of their manhood (Le duff et al., 2004).

Family History: In general, an individual with immediate family members that have a history of heart attack is likely to be at risk of heart-related diseases (Parthiban & Subramanian, 2008)

In this research paper, we will monitor controllable risk factors such as blood pressure, cholesterol level, chest pains with fasting blood, resting blood and fasting blood.

MACHINE LEARNING TECHNIQUES

Machine Learning (ML) techniques for data mining fall under the domain of Artificial Intelligence (AI) with aims to:

- Construct algorithms that can learn from experiences,
- Make accurate predictions for new data set, in this way ML becomes an intelligent theory of learning,
- Identify patterns that are very hard or impossible for human to detect themselves,
- Operate with large dataset, decisions and predictions.

Machine Learning algorithms generally used in data mining can be classified into three categories, that is, Supervised learning, Unsupervised learning and Re-enforcement (see

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Table 1). Machine Learning techniques identifies factors that are previously not known and visualizes them in a documented manner.

Table 1: Difference between Supervised, Unsupervised and Re-enforcement Learning.

Supervised Learning	Unsupervised Learning	Re-enforcement Learning
In this type of learning datasets exist with examples. Algorithms can learn from the dataset and respond to new input of what it has learnt.	Dataset does not control the response in the technique. Algorithms will attempt to recognize any similarity patterns between inputs and classify them based on similarity.	This technique falls in between supervised and unsupervised learning whereby the model performance improvement occurs as the technique interacts with the environment.

This research paper will apply the Supervised Machine Learning algorithm.

TECHNIQUES FOR DATA MINING

Data mining techniques are employed methods that can be utilized for data softening with the aim of identifying any patterns. The techniques include predictions, classifications and clustering.

Associate

Looks at any form of patterns that is formed based on connection from one event to another. In most cases, it is applied in predicting heart diseases whenever a patient of a similar risk is identified and further gives relations that contain unlike features of the space to be analyzed (Boxwala et al., 2004].

Clustering

This technique is based on Unsupervised Machine Learning (see Table 1).

Classification

This consists of a Supervised Learning approach, whereby samples of class label training are supplied. Mathematical methods such as k-n, decision tree, Naïve Bayes and artificial neural network are used for classification (Palaniappan & Awang, 2008).

Predication (Forecasting)

This method is used to determine data patterns which can formulate a future reasonable prediction. This technique can be associated with a prognostic model within data mining (Dangare & Apte, 2012).

Sequence

This method searches for similar patterns whereby one occurrence influences the next future occurrence (Dhanalakshmi, 2017).

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Our Research Study focused on Classification Methods as they relate well to Structure Machine Learning for prediction and monitoring of heart-related diseases.

ALGORITHMS FOR DATA MINING

Bayesian Classifiers

Through the use of Bayesian Classifier, systems can discover knowledge that has otherwise been concealed but can be associated with diseases based on a heart disease patient's historical medical record (Liu et al., 2016; Pattekari & Parveen, 2012). It predicts the class of membership probabilities using Bayes theorem.

Decision Tree

This is regarded as the most popular classifier due to its simplicity and ease of implementation. It does not require parameter setting or domain knowledge (Manivannan, 2016; Komal & Vekariya. 2015).

Neutral Networks

This is well known technique based on its accuracy of results. It uses a feed forward neural network model, back propagated learning algorithm and a variable learning rate (Shouman, Turner & Stocker, 2010).

Support Vector Machine

It is supervised machine learning that applies a state-of-the-art maximum classification algorithm, a technique for both linear and non-linear data classification. The algorithm does searches to identify best hyper planes that can be used to separate the transformed data into two different classes (Rani, 2011).

K-Nearest Neighbor

K-Nearest Neighbor (KNN) is a simple algorithm that stores all cases and classify new cases based on the similarities measured. It is classified into two types, that is, Structure less NN and Structure based NN (Rani, 2011).

In this research paper we adopt Decision Tree techniques as we deep it relevant to predict and monitor heart diseases.

TOOLS FOR DATA MINING

RAPID MINER

This is an open core model software platform that is used to provide data mining tasks that are fully integrated. Besides being a tool for data mining, it also has capabilities to allow additional plugins for data analysis algorithm creation.

WEKA

Waikato Environment for Knowledge Analysis (WEKA) is an open source platform that is under development in Java and issued under General Public License, GNU. Fundamentally, it is a collection of machine learning algorithms that can be used for data mining tasks such as virtualization, classification, clustering, data pre-processing and regression. Furthermore, it has the ability to process data results through the provision of the SQL database.

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MATLAB

Also known as Matrix Laboratory, MATLAB is amongst the versatile and powerful data mining tools that can be adopted to examine data through algorithm, model, and the development of applications. It can also be applied as a stand-alone data mining tool independent of other data mining tools.

ORANGE

Orange is an open source data mining and machine learning software that can be used for virtualization and explorative data analysis. It provides a platform for recommender systems, predictive modelling and experiments analysis. Furthermore, it can be applied in biomedicine, bioinformatics, teaching and genomic research. It is preferred when dealing with new emerging innovations, the quality thereof and the rollability of that emerging technology.

TANAGRA

This is an open source software dedicated to researchers, students and academics, purely for research purposes. The methods it proposes ranges from data analysis, machine learning, statistical learning and areas of database research. Its objective is to afford researchers, academics and students the easiest way to use data mining tools for analytics on synthetic or real data.

KNIME

Konstanz Information Miner (KNIME) is an open source platform that focuses mainly on data processing, integration, exploration and analysis. It uses concept modular data pipelining in order to integrate different machine learning and data mining components.

METHODOLOGY AND APPROACH

The below objectives are set out for heart disease monitoring, prediction and detection system prototype and simulation.

- The prediction, detections and simulation systems should not have assumptions about patient's records or prior knowledge that it intends to compare.
- The system selected for this test must be able to accommodate scalability against big databases that contain thousands of datasets.

THE WEKA TOOL

The approach chosen for this research work was implemented using the WEKA tool. WEKA is regarded as an open source software tool that is tailored for data mining and an accumulation of machine learning algorithms. WEKA consists of techniques for pre-processing, clustering regression, classification and visualization [4]. The explore mode is normally used to test for classification. For this study, a Decision Tree containing ten folds will be used.

In order to run the test, the following WEKA steps need to be carried out.

- Start by clicking WEKA Explorer,
- Open the saved dataset file in ARFF format,
- Click on the classify tab and select J8 etc. (from the tree) from the choose button,

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• Select the desired testing mode option then click the start button to start generating results.

The process can also be repeated for Logistic Model Tree and Random Forest Algorithms.

Data

For comparing various decision tree classification techniques, the Cleveland dataset adopted from UCI repository was used; the datasets are available at http://archieve.ics.uci.edu/ml/datasets/heart+disease. The datasets originally consisted of 76 attributes and 303 records. However, for the purpose of this research study only 13 attributes were used for testing as shown in Table 2.

Table 2: Testing Attributes Adopted in this Study.

Name	Type	Description
Age	Continuous	Age in years
Sex	Discrete	0 = Female 1 = Male
Cp	Discrete	Chest pain type: 1 = typical angina, 2 = atypical angina, 3 = non-angina pain 4 =asymptom
Trestbps	Continuous	Resting blood pressure (in mm Hg)
Chol	Continuous	Serum cholesterol in mg/dl
Fbs	Discrete	Fasting blood sugar>120 mg/dl: 1-true 0=False
Exang Continuous Maximum	Discrete	Exercise induced angina: 1 = Yes 0 = No
Heart rate achieved Thalach	Continuous	Maximum heart rate achieved
Old peak ST	Continuous	Depression induced by exercise relative to rest
Slope	Discrete	The slope of the peak exercise segment: 1 = up sloping 2 = flat 3 = down sloping
Ca	Continuous	Number of major vessels colored by fluoroscopy that ranged between 0 and 3.
Thal	Discrete	3 = normal 6 = fixed defect 7= reversible defect
Class	Discrete	Absent of heart disease Present of heart disease

RESULTS

Results from the study suggest that 150 patients had no heart related diseases and that 120 patients had heart-related diseases, with the majority between the age of 42 and 77. Around 20 patients had *Type 1* chest pains (severe angina), 42 patients had *Type 2* chest pains (mild

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angina), 79 patients experienced *Type 3* chest pains, that is, pains related to other body problems (non-angina pains that can be relieved immediately on lying down or pressing finger on the painful area) and 129 patients had *Type 4* chest pains (asymptomatic i.e. presenting no symptoms). Between the ages of 50 to 75, patients having heart disease were between the ages of 55 and 66 with a resting blood pressure (Tresbps) of 120 to 14 mm Hg.

CONFUSION MATRIX

A Confusion Matrix shown in Table 3 was constructed in the following manner:

- **True Positive (TP)** – This is an average of all the patients who have been correctly diagnosed.
- **False Negative (FN)** –This denotes the number of records that have been classified false while they were actually true.
- **False Positive (FP)** – This denotes the number of records that have been classified as true while they were actually false.
- **True Negative (TN)** – This denotes the number of records that have been classified as false and they were indeed false.

Table 3: Confusion Matrix.

	a (Has heart disease)	**b (No heart disease)**
a (Has heart disease)	TP	FN
b (No heart diseases)	FP	TN

Results of different Algorithms according to the Confusion Matrix are provided in Tables 4 to 8.

Table 4: Confusion Matrix for Naïve Bayes.

	a (Has heart disease)	**b (No heart disease)**
a (Has heart disease)	131	19
b (No heart diseases)	25	95

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Table 5: Confusion Matrix for SMO.

	a (Has heart disease)	b (No heart disease)
a (Has heart disease)	131	19
b (No heart diseases)	24	96

Table 6: Confusion Matrix for J48.

	a (Has heart disease)	b (No heart disease)
a (Has heart disease)	119	31
b (No heart diseases)	32	88

Table 7: Confusion Matrix for RMT.

	a (Has heart disease)	b (No heart disease)
a (Has heart disease)	126	24
b (No heart diseases)	26	94

Table 8: Confusion Matrix for KNN.

	a (Has heart disease)	b (No heart disease)
a (Has heart disease)	115	35
b (No heart diseases)	32	88

Comparison of Methodologies

In this research study, five algorithm form classifications were primarily applied for the development of a Heart disease model. In terms of dataset testing and sampling, ten folds cross-validation with 66% data slit was applied. The experiment performance and its accuracy were evaluated using performance measures such as True Positive (TP) rate, Precisions, F-measure, Kappa statistics, Receiver Operating Characteristic (ROC) area and the Root Mean Square (RMS) error. In order to demonstrate the best algorithm technique for accurate heart diseases prediction, algorithms that were applied in these experiments were compared using various parameters as listed in Table 9.

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Table 9: A Comparison of Different Algorithms Using Various Performance Measures.

Algorithms/ Performance Measure	Naïve Bayes	KNN	SMO (SVM)	J48	Random Forest
Accuracy %	84%	75%	84%	76%	81%
TF rate	0.837	0.752	0.841	0.767	0.815
Precision	0.837	0.753	0.841	0.766	0.815
F-measure	0.837	0.752	0.840	0.767	0.815
ROC curve	0.898	0.750	0.837	0.744	0.899
Kappa Statistics	0.668	0.498	0.676	0.527	0.624
RMS error	0.359	0.496	0.399	0.460	0.338

CONCLUSION

The Cleveland data set, which applied Naïve Bayes classifier managed to score 84% accuracy against SMV which scored 83%. Random Forest produced an accuracy score of 81%, whereas KNN produced 75% and lastly, J48 produced 76%. A correlation between the number of attributes used and the level of accuracy which was applied during the creation of the classifier was found. Naïve Bayes managed to attain the score of 0.898 (or 0.9) in ROC area, which is a promising accuracy score towards the optimal or perfect classifier.

After a closer look into the experimental results, it has become clear that the objective to attain and produce accurate heart disease prediction with required level of accuracy was a success. This was achieved by developing machine models to predict heart related disease accuracy, using clean datasets to compare these models through different classification techniques.

REFERENCES

Boxwala A.A., "Organization and representation of patient safety data: Current status and issues around generalizability and scalability," *J. Am. Med. Informatics Assoc.*, vol. 11, no. 6, pp. 468–478, 2004.

Dangare C.S. and Apte S.S., "Improved Study of Heart Disease Prediction System using Data Mining Classification Techniques," *Int. J. Compute. Appl.*, vol. 47, no. 10, pp. 44–48, 2012.

Dhanalakshmi D.B.U.R., "A Comprehensive Survey of Students Performance Using Various Data Mining Techniques," *Int. J. Sci. Res.*, vol. 6, no. 4, pp. 2233–2238, 2017.

Guru N., Anil D., and Rajpal A., "Decision Support System for heart Disease diagnosis using Neural Network", Delhi Business Review, Vol. 8, No. 1 (January –June 2007).

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Helma C., Gottmann E., and Kramer S., “Knowledge discovery and data mining in toxicology,” *Stat. Methods Med. Res.*, vol. 9, no. 4, pp. 329–358, 2000.

Le Duff F., Munteanb C., Cuggiaa M. and Mabob P., “Predicting Survival Causes after out of Hospital Cardiac Arrest using Data mining Method”, Studies in health technology and informatics, Vol. 107, No. pt2 pp. 1256-9, 2004.

Lee H.G., Noh K.Y. and Ryu K.H., “Mining Biosignal Data: Coronary Artery Disease diagnosis using Linear and NonLiniar features of HRV,” LNAI 4819: Emerging Technologies in Knowledge Discovery and Data Mining, pp. 56-66. May 2007.

Komal G. and Vekariya V., “An Approach to Secure Data in Disruption Tolerant Network,” *Int. J. Innov. Res. Comput. Commun. Eng.*, vol. 3, no. 11, pp. 0396–0400, 2015.

Lateef M., Iqbal Z., Akhtar M.S., Jabbar A., Khan M.N., and Gilani A. H., “Preliminary screening of Trachyspermum ammi (L.) seed for anthelmintic activity in sheep,” *Trop. Anim. Health Prod.*, vol. 38, no. 6, pp. 491–496, 2006.

Liu X., Lu R., Ma J., Chen L., and Qin B., “Privacy-Preserving Patient-Centric Clinical Decision Support System on Naïve Bayesian Classification,” *IEEE J. Biomed. Heal. Informatics*, vol. 20, no. 2, pp. 655–668, 2016.

Manivannan K., Rowan A.G., Tanaka Y., Taylor G.P., and Bangham C.R.M., “CADM1/TSLC1 Identifies HTLV-1-Infected Cells and Determines Their Susceptibility to CTL-Mediated Lysis,” *PLoS Pathog.*, vol. 12, no. 4, 2016.

Noh K., Lee H.G, Shon H.S., Lee B.J and Ryu K.H, “Associative Classification Approach for Diagnosing Cardiovascular Disease” Springer, Vol: 345, pp: 721-727, 2006.

Palaniappan S., and Awang R., “Intelligent heart disease prediction system using data mining techniques,’’ pp.108-115, 2008.

Pattekari A., Parveen S.A., “Prediction system for heart disease using Naïve Bayes,” *Int. J. Adv. Comput. Math. Sci.*, vol. 3, no. 3, pp. 290–294, 2012.

Parthiban L. and Subramanian R., “Intelligent Heart Disease Prediction System using CANFIS and Genetic Algorithm“, International Journal of Biomedical and Medical Sciences, Vo. 3, No. 3, 2008.

Public G. and Security H., “A safer,” 2007.

Rani K. U., “Analysis of Heart Diseases Dataset Using Neural Network Approach,” *Knowl. Manag.*, vol. 1, no. 5, pp. 1–8, 2011.

Singh Y., and Chauhan A.S., “Neural Networks in data mining”” Journal of Theoretical and Applied Information Technology, 2005 -2009 JATIT.

Shouman M., Turner T., and Stocker R., “Using decision tree for diagnosing heart disease patients,” *Conf. Res. Pract. Inf. Technol. Ser.*, vol. 121, no. July 2014, pp. 23–30, 2010.

Yanwei X., Wang J., Zhao Z., Gao Y., “Combination data mining models with new medical data to predict outcomes of coronary heart disease”. Proceedings International Conference on Convergence Information Technology 2007, pp 868-872.

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DIGITAL SKILLS AND EMPLOYABILITY IN THE SOUTH AFRICAN GIG ECONOMY

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ABSTRACT

Aim/Purpose Due to high levels of unemployment that persist in the global South, particularly in South Africa, governments and policy makers are increasingly considering the growing digital gig economy as a viable job creation strategy. In order to take advantage of this nascent form of employment opportunity, it is critical to understand the types of technical skills necessary to enhance the employability of potential digital gig workers. The aim of this research is to explore potential job-relevant technical skills required to gain employment in South Africa's digital gig economy sector.

Background The growth of the digital gig economy is disrupting the employment landscape across the globe (Martin, 2016). This economy provides a potential pathway for millions of unemployed people, particularly those in the global South economies that are battling the scourge of slow economic growth and high rates of joblessness. While many people consider themselves 'digitally savvy' by virtue of their daily usage of digital technologies, many are not equipped with the relevant technical skills required in the digital gig economy. In order to address this job-skills gap, this study examines job advertisements available for South Africans on several digital labor platforms in order to understand the types of digital skills employers require.

Methodology A Conceptual Content Analysis (CCA) of two hundred and twenty (N=220) digital gig job advertisements from three (3) significant gig platforms was undertaken over a three-month period in 2019 to qualitatively develop a descriptive set of core technical skill requirements for digital gig jobs.

Contribution This research study identifies specific digital skills that governments and policy makers should focus on over the short, medium and long term. This would potentially improve employability in the digital gig economy.

Findings An analysis of the gig job advertisements available for South African gig workers highlights the importance of technical and interpersonal (soft) skills. The type of technical skills required for digital gig jobs vary from basic (using digital technologies for basic tasks such as searching, handling and storing digital content), intermediate (using digital technologies for specific work related tasks such as graphic and web design) to advanced technical skills such as programming, artificial intelligence, data analysis, cyber security and web development expertise. The five (5) most common job categories (intermediate to advanced) identified from the sample were a) Application and Software Development (Python, JavaScript and PHP programming) b) IT & Network Analysis (Linux & Amazon Cloud/Web Services skills), c) Information Security

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(Security Analyst), d) Database Administration (SQL skills) and e) Data Science (Software Testing, Data Visualization, Machine learning and AI using Python).

Recommendations for Practitioners Policy makers should focus on how to integrate digital skills development, including the broad categories identified in this research, into a school curriculum as well as post-school skills development initiatives in a way that is accessible to those mostly affected by unemployment.

Recommendation for Researchers Researchers should monitor, evaluate and theorize the digital skills impact emanating from the fast-paced emerging digital gig economy in order to understand the unemployment, under-employment and unemployability in the digital economy sector.

Impact on Society In order to address the unemployment conundrum in South Africa, a better understanding of digital skills appropriate for the new digital economy could significantly contribute to a meaningful skills capacity building through the re-skilling and upskilling of future digital gig workers.

Future Research Further research is required to explore other factors that could enable better adoption of digital skills strategies across the various sectors of society.

Keywords Digital Skills, Employability, Digital Platform Economy, Gig Economy.

INTRODUCTION

Digital labor platforms are increasingly becoming the de facto mode of work and income generation for millions of workers in the global South (Kässi & Lehdonvirta, 2016; Berg et al., 2018). In these platforms, also called the 'gig economy', 'platform economy', 'sharing economy' etc., workers across multiple geographies earn or supplement their income through competitively bidding for work or tasks (known as 'gigs') posted by clients through online labor platforms such as Upwork, Freelancer, Money4Jam and many others (Graham, Hjorth & Lehdonvirta, 2017). The rise in the demand for work as populations grow as well as the widening access to broadband technology, particularly in previously digitally excluded places such as South Africa, provides a fertile ground for the growth of digital labor platform work (Mtsweni & Burge, 2014).

This research makes a distinction between traditional digital labor and digital gig labor. The former refers to traditional IT jobs in the context of existing industries and organizations using traditional employment structures while the latter refers to flexible online labor arrangements, typically platform-driven "one-job-per-contract" based labor, using the Heeks (2017) taxonomy. The study also excludes the *physical* gig economy, which refers to those services acquired via an online platform that are tangible and physical location-bound like Uber and AirBnB. It is an ongoing debate among researchers as to what the exact size of the digital gig economy and the digital gig labor market in Africa is (UNCTAD, 2019). In order to monitor the growth of the overall gig economy, an Online Labor Index (OLI) has been developed by Oxford academics (OLI, 2020a). According to this dynamic index, which "measures the supply and demand of online freelance labor across countries and occupations by tracking the number of projects and tasks across platforms in real time" (Kässi & Lehdonvirta, 2018), Africa ranks only higher than South America but is below all major world regions.

The index also shows (*as at Jan 2020*) that writing and translation services accounts for 34.6% of digital gig jobs in Africa, while creative and multimedia work accounts for 28,2% and software development and technology accounts for 26.8%. The remaining 10.4% is distributed between clerical and data entry, sales and marketing tasks as well as professional services (OLI, 2019). Despite the benefit of flexible working arrangements, which makes platform labor

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particularly convenient for marginalized groups such as women and the disabled, its uptake in Africa remains impeded by the lack of appropriate and job-relevant digital skills (Mothobi et al., 2018; Roomaney et al., 2018). Africa is the world's youngest region in terms of population composition, with 60% of Sub-Saharan Africa's population below the age of 25 years and 60% of those unemployed being below the age of 40 years (WEF, 2017). Despite this gloomy unemployment picture, most regions in Africa have started experiencing sustainably high economic growth rates (AfDB, 2019).

This has led the International Finance Corporation (IFC) of the World Bank to estimate that the Sub-Saharan Africa's market size that require digital skills will be more than 230 million jobs by the year 2030, translating to over 650 million skills training opportunities if re-training is factored in (IFC, 2019). The African Development Bank projects a sustained economic growth for Africa in the next decade (AfDB, 2019). This view, coupled with the improving levels of education among African job seekers (IFC, 2019), positions the continent favorably for a potential digital labor skills revolution. A strong growing digital economy could potentially provide employment opportunities to a young and dynamic generation of new African digital gig workers. For this opportunity to be realized, a clearer understanding of the core technical skills that can improve the employability of workers in the gig economy in the context of Africa is required.

The aim of this research is to explore job-relevant technical skills required for employment in South Africa's growing digital gig economy. The research question guiding this research is "What are the job-relevant technical skills requirement for digital gig work in South Africa?" The structure for rest of the paper is as follows. The next section provides an overview of the study's key concepts; employability, the digital gig economy, digital skills and existing national skills initiatives. The second section discusses the research methods used, followed by the third section's analyses of the findings and a concluding final section.

BACKGROUND

This Section briefly discusses the main concepts guiding this study. Firstly, we discuss the concept of employability and its varied meanings in academic literature. Secondly, we discuss the idea of skills, focusing on digital skills. Thirdly, we discuss the multiple meanings attached to the concepts of the digital gig economy and digital gig work. We sum up the discussion by looking at some of the current digital skills development initiatives across South Africa and how these can be catalytic in an effort to improve the employability of South Africans in the digital economy.

Employability

Scholars, think-tanks, governments and policy makers globally have been grappling with the meaning and implications of 'employability' for several decades (Hillage & Pollard, 1998; McQuaid & Lindsay, 2002, ECD, 1998; CEC, 1999; ILO, 2000; UN, 2001). Since the introduction of modern computing, the Internet and more recently, rapid digitalization of work activities and processes, society has grappled with the challenge of keeping people gainfully employed alongside competition and possible replacement by automation and artificial intelligence (Fossen & Sorgner, 2018). This idea finds support in various studies that have predicted a global mass replacement of humans by machines (digitalization) in the near future (Frey & Osborne, 2017; Arntz et al., 2017; Sorgner et al., 2017). Hillage & Pollard (1998) define employability as "being capable of getting and keeping fulfilling work" as well as "the capability to move self-sufficiently within the labor market to realize potential through

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sustainable employment." Pool and Sewell (2007) define employability as "having a set of skills, knowledge, understanding and personal attributes that make a person more likely to choose and secure occupations in which they can be satisfied and successful." While skills (knowledge and education) are central to the concept of employability, it is important to recognize that the concept encompasses far more dimensions and assets. These include assets such as an individual's attitude, self-esteem, self-efficacy, emotional intelligence, an ability to meaningfully use or deploy these assets, an ability to present and communicate the assets as well the context of personal circumstance (Hillage & Pollard, 1998; Pool & Sewell, 2007). This research limits itself to the skills requirement dimension only.

Digital Skills

UNESCO's report on 'Digital Skills for Life and Work', published in 2017, outlines three broad but distinct areas of digital skills: (1) Basic functional digital skills (2) Generic digital skills and (3) Higher level skills as shown in Table 1.

Table 1: Understanding Digital Skills (developed by authors from the UNESCO (2017) report).

Digital Skills Category	Definition	Application
1. Basic functional digital skills	"Accessing and engaging with digital technologies." p. 27	Foundational skills essential to access and begin to use digital technologies (World Bank, 2016) that allow an individual to: • Operate digital devices, • Connect to the internet, • Set up accounts and profiles, • Access and search information and resources.
2. Generic digital skills	"Using digital technologies in meaningful and beneficial ways." p. 27	This encompasses skills such as (TPDeg, 2017): • Information handling, • Online communication, • Transactions and financial management, • Ability to create digital content such as text posts and images, • Ability to make use of digital tools to solve practical problems.
3. Higher level digital skills	"Using digital technology in empowering and transformative ways." p. 29	This includes specialist and advanced ICT skills such as: • Computer-programming skills (coding), • Emphasis on the concept of computational thinking (Scullard et al., 2019).

Participation in the digital gig economy assumes the existence of competencies in all three categories to varying degrees based on the category of the occupation/job/task under consideration.

Digital Gig Economy Work

The view of digital gig labor adopted for this study is based on the Heeks (2017) definition for online labor which in turn is based on previous work by Horton (2010), Lehdonvirta et al. (2014) and Graham et al. (2017b). It describes digital gig labor as "as contingent (task or project based) intangible work delivered digitally and done for money, organized via online outsourcing platforms that are marketplaces bringing together buyers and sellers" (Heeks,

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2017, p. 1). Schmidt (2017) breaks down the digital economy work into two major distinct spheres; (1) Cloud work (web-based digital gig work) and (2) Physical gig work (location-based digital labor) such as Uber (transportation and delivery), AirBnB (accommodation) and SweepSouth (household and personal services). This paper primarily focusses on the first category (digital gig work). The separation of the various categories of digital gig work (cloud work) can be easily blurred in practice hence a recommendation by Heeks (2017) to view them as a "continuum of online labor" (p. 3) from online freelancing to microwork shown in Table 2.

Table 2: Categorizing Digital Gig Work - developed by authors from Schmidt (2017).

Digital Gig Work (Cloud Work)	Characterization	Examples
Online freelancing	• Also referred to as online outsourcing, outsourcing marketplaces or the online staffing industry • Digital nomads or freelancers are contracted by organizations, typically overseas, to provide specialized skills	In the past, companies such as eLance, oDesk and Freelancer.com provided services such as online meeting place for worker and clients. The first two organizations merged into a company called Upwork.
Micro-tasking (crowd work)	• Masses of tiny, repetitive tasks that are distributed across a large and • unspecified group of crowd workers • Commercial and paid work • Tasks range from easy that require Basic Digital Skills (Level 1) but could also require up to Level 3 • (Advanced Digital Skills)	Companies such as MTurk, Clickworker and CrowdFlower lead this market with work tasks such as; • Validating existing data sets (e.g. addresses, street names etc.) • Digitization of business cards • Transcription of audio recordings • Writing of product descriptions • Social sentiment analysis • Online content moderation etc.
Contest-based creative crowd work	• Many cloud workers compete/contest for the task issued by a client but only one result (best suited or preferred by the client) is used and paid for while the rest are discarded	• Most of the contest work is in the area of logo design • Can also range from more complex tasks, such as web design, developing marketing campaigns and open innovation projects for large companies

The Online Labor Index developed by Oxford University researchers has proposed six (6) generic occupation class names that span the spectrum of digital gig economy work as shown in Table 3. This classification is largely based on Upwork.com's classification (Kässi & Lehdonvirta, 2018).

Table 3: Categorizing Digital Gig Work Occupation classes - based on Kässi and Lehdonvirta (2018).

Occupation Category	Typical Projects/Jobs
Clerical and Data entry	Accounting, Consulting, Financial Planning, Legal Services, Human Resources, Project Management.
Creative and Multimedia	Customer Service, Data Entry, Transcription, Tech Support, Web Research, Virtual Assistant.
Professional Services	Animation, Architecture, Audio, Logo Design, Photography, Presentations, Video Production, Voice Acting.

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Occupation Category	Typical Projects/Jobs
Sales and Marketing Support	Ad posting, Lead Generation, Search Engine Optimization, Telemarketing.
Software Development and Technology	Data Science, Game Development, Mobile Development, QA and Testing, Server Maintenance, Software Development, Web Development, Web Scraping.
Writing and Translation	Academic Writing, Article Writing, Copywriting, Creative Writing, Technical Writing.

DIGITAL SKILLS INITIATIVES IN SOUTH AFRICA

A survey of 2 012 South Africans revealed that 34% of adults who do not possess formal school education, have not secured post-school skills training and 17% of University graduates report that they are not learning any new digital skill (PwC, 2019). Fifty-three percent (53%) of the survey respondents reported a concern that their jobs are at great risk of automation in the next decade. The most positive news from the survey was that 77% of the respondents were prepared and willing to learn new digital skills in order to improve their employability. Despite this optimistic attitude, other surveys have revealed a significant digital skills gap that exists in South Africa (JCSE, 2019). Multinational corporations such as Facebook, Microsoft, SAP and Google have launched digital skills initiatives in South Africa (LiquidTelecom, 2019). Government and non-governmental organizations such as the Harambee Youth Employment Accelerator, the Youth Employment Service (YES), the National Youth Development Agency (NYDA), the South African Youth Development Organization (SAIDO), Vuka'zenzele, the Cape IT Initiative (CITI), WeThinkCode and many others are helping South Africans to acquire and develop digital skills to ultimately improve their employability. However, there is a need to develop an empirically grounded view of the digital gig jobs that are available in order to understand the types of digital skills they require.

METHODOLOGY

In order to contribute towards addressing the employability conundrum through digital skills in the growing digital gig economy, the following activities were undertaken to gain an insight of the skills requirement profile:

1. Upon receiving institutional ethical clearance, three (3) major digital gig work platforms namely Upwork.com, Guru.com and Freelancer.com were selected due to their ease of access as well as the availability of a number digital gig job adverts available for South Africans. The use of job advertisements is a ‘time-honored methodology’ in information science studies (Starr, 2004). Harper (2012) dates back the tradition to the 1970’s with the main motivation being the need to examine the changing nature of skills in the workplace.
2. Over a period of 3 months (June, July and August) of 2019, a total of 220 advertised digital gig jobs, publicly available on the three gig platforms, were obtained and prepared (i.e. copied, cleaned and initially categorized) in a spreadsheet. Harper (2012) states that the majority of job advert analysis studies sample between 1 and 199 jobs and most are conducted over a period of less than 1 year as adverts tend to expire and removed. Most studies tend to analyze current data.
3. The spreadsheet data was imported and coded into the NVivo 12 qualitative data analysis software to derive concepts and themes from the raw data. The categorization in Table 3 was used to guide the coding and where data did not align to the guiding

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framework, general induction method was used to categorize the emerging data (Thomas, 2006).

4. Content analysis is an established research approach used to determine the presence of certain words, themes, or concepts within some given qualitative data. There are two general types of content analysis namely Relational Content Analysis (RCA) and Conceptual Content Analysis (Busch et al., 2012). The RCA determines the existence and frequency of concepts in a text while the CCA develops the analysis further by examining the relationships among concepts in a text. For this research, the CCA approach was used to determine the nature and frequency of skills in job categories (Busch et al., 2012). The job advertisements were coded into manageable content categories, a process known as selective reduction. The protocol for CCA followed is shown in Table 4.

Table 4: Conceptual Content Analysis Process (Busch et al., 2012).

Steps for Conducting Conceptual CA	Application of the Process Step
1. Decide the level of analysis.	The researcher decides whether to code for a single word or for sets of words or phrases. The approach for this research was to code for phrases and sentences in order to identify skills.
2. Decide how many concepts to code.	The researcher determines whether to develop a pre-defined or interactive set of concepts and categories to code for. A hybrid approach was chosen for this research. Table 3 served as a pre-defined set of categories, but flexibility was allowed for categories that did not fit the predefined set.
3. Decide whether to code for existence or frequency of a concept.	This research will be coding for frequency of a concept and noting the number of times a concept appears in a text to gauge importance.
4. Decide on how you will distinguish among concepts.	The researcher must decide on the level of generalization, i.e. whether concepts are to be coded exactly as they appear, or if they can be recorded as the same even when they appear in different forms. For this research, the text will be coded the same when they appear in different forms. For instance, jobs often overlap therefore similar jobs will fall into the same classification.
5. Develop rules for coding your texts.	After steps 1-4 are successfully executed, rules for translation of text into codes were developed. This keeps the coding process coherent, organized and consistent, which improves validity.
6. Decide what to do with "irrelevant" information.	The researcher must decide whether irrelevant information should be ignored or used to re-examine and/or alter the coding scheme. For this research. Irrelevant words/phrases were not coded.
7. Code the texts.	Once these choices about irrelevant information are made, the next step is to code the text. Coding was undertaken using the NVivo 12 software.
8. Analyze the results.	Once the coding is done, the researcher examines the data and attempts to draw whatever conclusions and generalizations possible. The results for this research are outlined in the Findings Section.

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FINDINGS

SAMPLES ANALYSIS

Figure 1 shows a typical digital gig job advert from Upwork.com on the left and the distribution of the 220 adverts gathered per platform (over 73% from Upwork, the biggest platform globally).

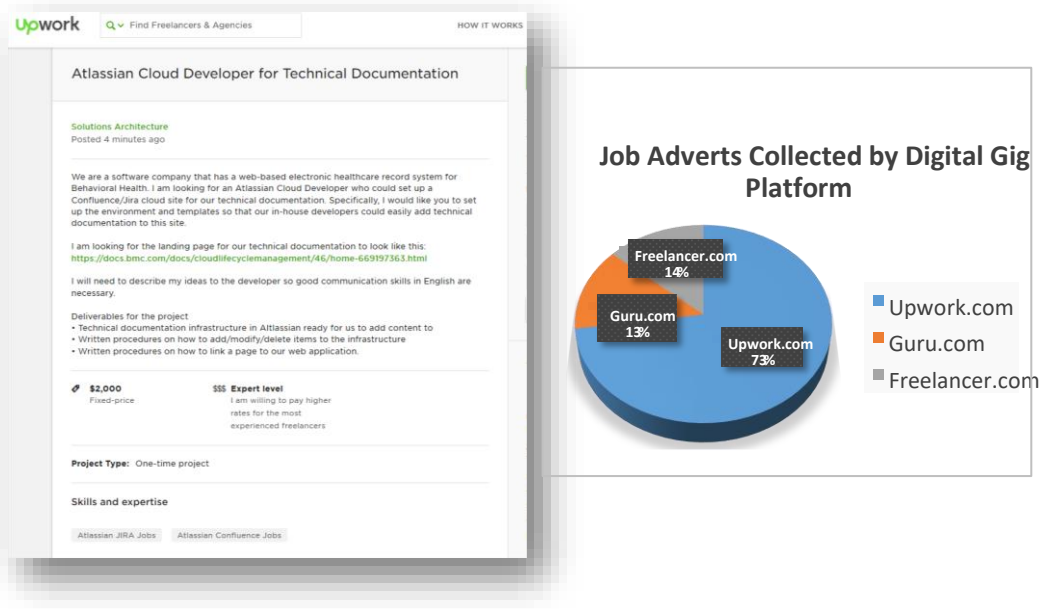

Figure 1: A Sample Digital Gig Job Advert (left) and the Advert Breakdown by Platform (right).

The sample in Figure 2 shows a huge concentration of digital gig jobs in the USA (N = 74; 33.6%), followed by India (N = 26; 11,8%). The UK and Canada account for 7.7% and 5.5% respectively. Only two African countries, South Africa (N = 6; 2.7%) and Nigeria (N = 4; 1.8%) had clients advertising digital gig jobs.

There are digital gig labor platforms that are locally focused, and this could account for the fact that a country like South Africa had a low count, e.g., NoSweat, Freelance Cape Town, Southern African Freelancers' Association (SAFREA) among others. Fifty-two (52) countries formed part of the global client location spread.

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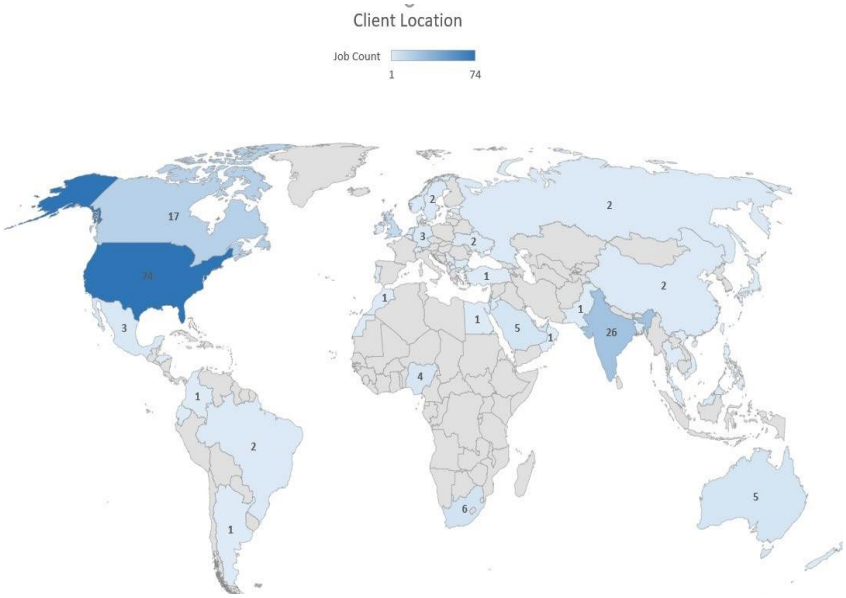

Figure 2: Client Geographic Location Profile and Job Counts.

Figure 3 shows an NVivo word cloud diagram that depicts the word frequency for the skills emanating from the all job advertisements. In total, over 400 technical skills were discovered from the adverts.

Figure 3: Digital Skills Frequency.

The skills with the most frequency in the sample are Programming Languages (Python, JavaScript, PHP and Java), followed by Data Management skills (data mining and SQL), followed by Data/Web Scrapping, and closely followed by Machine Learning. These three top skills broadly fall into the ‘Software Development and Technology’ category.

DIGITAL SKILLS CATEGORY DEMAND

Using the occupation category framework in Table 3, the ‘Software Development and Technology’ accounted for most of the digital gig job demand by clients in our sample of 220 adverts with 43% of the demand, followed by the ‘Creative and Multimedia’ (28%) category

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and ‘Writing and Translation’ (16%). The remaining 13% is distributed between the following categories: ‘Clerical and Data Entry’ (5%), Sales and Marketing Support (4%) as well as ‘Professional Services’ (4%).

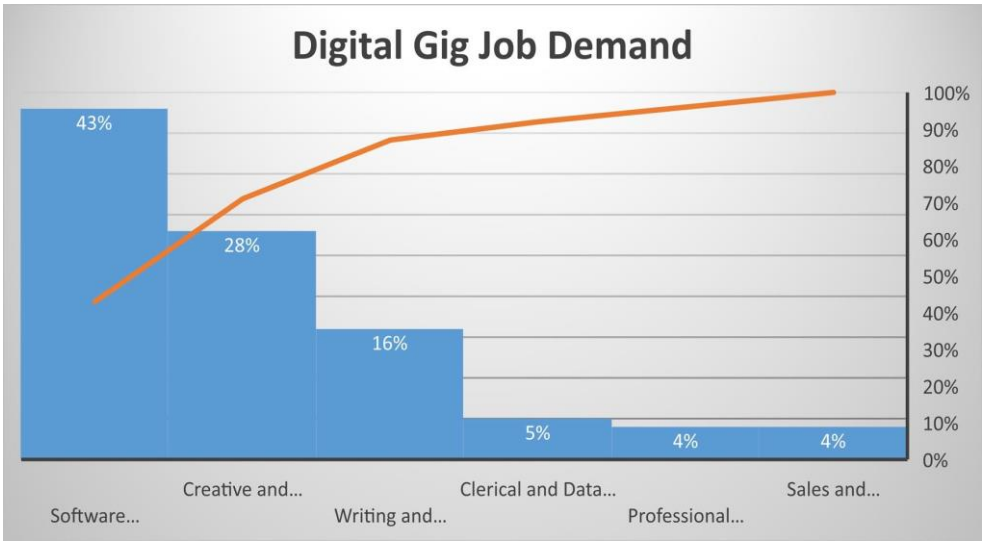

Figure 4. Digital Skills Category Demand.

A further analysis of the most dominant skills category, ‘Software Development and Technology’, reveals the skills sub-categories in Table 5, with Python, JavaScript, PHP and Java being the dominant coding skills across most of the categories.

Table 5: Dominant sub-categories of the Software Development and Technology.

Skills Sub-category	Examples
Software Development	Desktop Software Development, E-commerce Development, Game Development, Mobile Development, Product Management, QA & Testing, Scripts & Utilities, Web Development/Front-End Development, Web & Mobile Design.
IT & Network	Networking, Hardware & System Admin/Network & System Administration, DevOps Engineering/DevOps, ERP/CRM/S.
Information Security	Information Security Professionals, Security Testing.
Database Administration	Database Administration (mostly SQL).
Data science	A/B Testing, Data Visualization, Data Extraction /ETL/ Web Scraping, Machine Learning, Data Mining & Management, Quantitative Analysis, Artificial Intelligence.

DISCUSSION

The aim of this research was to explore the job-relevant technical skills required for meaningful participation (employment) in South Africa’s growing digital gig economy. The Conceptual Content Analysis of digital gig work adverts, particularly those accessible to South African workers online, show that Software Development, IT Networks expertise, Information Security related skills, Database Administration and Data analysis skills tend to be the often-required job-relevant digital skills to develop. Programming languages such as Python, JavaScript, PHP and Java and among the most job-relevant digital skills on demand, including Data

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Management skills such as Data Mining and SQL skills, followed by Data/Web Scrapping, closely followed by Machine Learning.

Our analysis shows that Website Content Scraping (either for competitive price analysis and contact scraping for email and phones numbers) using bots and web crawlers (software applications designed and programmed to do specific tasks), tend to be among the high paying and relatively low effort tasks that can be financially rewarding.

An important discussion regarding the dark side of digital gig labor platforms needs to accompany a discussion regarding digital gig skills. Various scholars have conducted critical research to shine the light on the exploitative nature of these types of platforms (Fuchs, 2014; Bergvall-Kåreborn & Howcroft, 2014; Wood et al., 2019). The Fairwork Foundation (Graham et al., 2019) has proposed an intervention around the quality of work on digital labor platforms which assesses the extent to which digital labor platforms practice fairness with regards to how they pay workers, the conditions of employment, the fairness of contracts, the fairness of management principles and worker representation. It is therefore important as the debates regarding digital skills for digital gig labor are explored, that the fairness aspect is not neglected in order to create employability skills for decent work.

CONCLUSION

Policy makers should consider focusing on how to integrate digital skills development, including the skills categories identified in this research, into a school curriculum as well as post-school skills development initiatives in a way that is accessible to those mostly affected by unemployment. Researchers should monitor, evaluate and theorize the digital skills impacts emanating from the fast-paced emerging digital gig economy in order to understand the unemployment, under-employment and unemployability in the digital economy better. In order to address the unemployability conundrum in South Africa, a deeper understanding of the digital skills requirements of the new digital economy could significantly contribute to the meaningful skills capacity building efforts through re-skilling, cross-skilling and upskilling of unemployed and the under-employed for future digital gig work opportunities. The limitations of this study are two-fold: firstly, the data is cross-sectional and gathered over short period of 3 months. Secondly, job advert data only reflects what potential employers require at a given point in time, and not how the demand evolves and not necessarily what jobs the workers are taking up. Therefore, a longitudinal study with a larger sample, both historical and dynamic as well as interviews with digital gig workers will give a more realistic approximation of the digital skills requirement. Finally, further research is required to explore other factors that could enable better adoption of digital skills strategies across the various sectors of society.

REFERENCES

African Development Bank (AfDB). (2019). African Economic Outlook 2019. Available Online https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/2019AEO/AEO_2019-EN.pdf. Last Accessed 15 January 2020.

Berg, J., Furrer, M., Harmon, E., Rani, U., & Silberman, M. S. (2018). Digital labor platforms and the future of work. *Towards Decent Work in the Online World. Rapport de l'OIT*.

Bergvall-Kåreborn, B., & Howcroft, D. (2014). Amazon Mechanical Turk and the commodification of labor. New technology, work and employment, 29 (3), 213-223.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Busch, C., & Paul, S. (2012). De Maret, Teresa Flynn, Rachel Kellum, Sheri Le, Brad Meyers, Matt Saunders, Robert White, and Mike Palmquist. (2005). Content Analysis. Writing@ CSU. Colorado State University Department of English. Available Online Available at https://writing.colostate.edu/guides/guide.cfm?guideid=61. Last Accessed: 12 Jan 2020.

Fossen, F. M., & Sorgner, A. (2018). The Effects of Digitalization on Employment and Entrepreneurship. mimeo.

Fuchs, C. (2014). Digital Labor and Karl Marx. Routledge.

Graham, M., Hjorth, I., & Lehdonvirta, V. (2017). Digital labor and development: impacts of global digital labor platforms and the gig economy on worker livelihoods. Transfer: European Review of Labor and Research, 23 (2), 135-162.

Graham, M., Woodcock, J., Heeks, R., Fredman, S., Du Toit, D., van Belle, J. P., Mungai., P & Osiki, A. (2019). The Fairwork Foundation: Strategies for Improving Platform Work. In Weizenbaum Conference (p. 8). DEU.

Harper, R. (2012). The collection and analysis of job advertisements: A review of research methodology. Library and Information Research, 36 (112), 29-54.

Heeks, R. (2017). Digital Economy and Digital Labor Terminology: Making Sense of the 'Gig Economy', 'Online Labor', 'Crowd Work', 'Microwork', 'Platform Labor', etc. Development Informatics Working Paper, (70).

Hillage, J., & Pollard, E. (1998). Employability: developing a framework for policy analysis (Vol. 107). London: DfEE.

International Finance Corporation (IFC). (2019). Digital Skills in Sub-Saharan Africa. Available online: https://www.ifc.org/wps/wcm/connect/ed6362b3-aa34-42ac-ae9fc739904951b1/Digital+Skills_Final_WEB_5-7-19.pdf?MOD=AJPERES. International Finance Corporation of the World Bank. Last accessed: 20 January 2020.

Joburg Centre for Software Engineering (JCSE). (2019). The 2019 ICT Skills Report. Available Online https://www.iitpsa.org.za/wp-content/uploads/2019/09/2019-JCSE-IITPSA-ICT-Skills-Survey-v1.pdf. Last accessed 12 Jan 2020.

Kässi, O., & Lehdonvirta, V. (2018). Online labor index: Measuring the online gig economy for policy and research. Technological forecasting and social change, 137, 241-248.

LiquidTelecom. African Digital Skills Report. (2019). Available Online https://www.liquidtelecom.com/download/track/liquid_telecom_digital_skills_report.pdf. Last accessed 11 Jan 2020.

Martin, C. J. (2016). The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? Ecological Economics, 121, 149-159.

McQuaid, R. W., & Lindsay, C. (2002). The 'employability gap': long-term unemployment and barriers to work in buoyant labor markets. Environment and Planning C: Government and Policy, 20 (4), 613-628.

Mtsweni, J., & Burge, L. (2014). The potential benefits of mobile microwork services in developing nations: Research opportunities and challenges. In 2014 IST-Africa Conference Proceedings (pp. 1-10). IEEE.

Mothobi, O., Schoentgen, A., & Gillwald, A. (2018). What is the state of microwork in Africa? A view from seven countries. Policy Paper, 5.

PriceWaterhouseCoopers (PwC). (2019). Upskilling Hopes and Fears Survey. Available Online: https://www.pwc.com/gx/en/issues/upskilling.html. Last Accessed: 16 January 2020.

Starr, J. (2004). A measure of change: Comparing library job advertisements of 1983 and 2003. LIBRES: Library and Information Science Research Electronic Journal, 14 (2).

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

UNCTAD. (2019). Digital Economy Report 2019: Value creation and capture–Implications for developing countries.

Roomaney, Z., Van Belle, J. P., & Tsibolane, P. (2018). Mobile Microwork in South Africa: Attitudes, Experiences and Barriers. In American Conference on Information Systems. Association of Information Systems.

Schmidt, F. A. (2017). Digital labor markets in the platform economy: Mapping the political challenges of crowd work and gig work. Bonn: Friedrich-Ebert-Stiftung.

Scullard, S., Tsibolane, P., & Garbutt, M. (2019). The Role of Scratch Visual Programming in the Development of Computational Thinking of Non-IS Majors. PACIS2019. Available Online: http://www.pacis2019.org/wd/Submissions/PACIS2019_paper_524.pdf. Last Accessed 03 Jan 2020.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. American journal of evaluation, 27 (2), 237-246.

OLI. (2019). The Online Labor Index. Available online: https://ilabour.oii.ox.ac.uk/online-labour-index/. Last accessed 20 January 2020.

Wood, A. J., Graham, M., Lehdonvirta, V., & Hjorth, I. (2019). Networked but commodified: The (Dis) embeddedness of digital labor in the gig economy. Sociology, 53 (5), 931-950.

World Economic Forum. (2017). The Future of Jobs and Skills in Africa Preparing the Region for the Fourth Industrial Revolution. Available online: http://www3.weforum.org/docs/WEF_EGW_FOJ_Africa.pdf. Last Accessed 10 January 2020.

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DIGITAL TRANSFORMATION IN THE CONTEXT OF THE 4IR: A CASE STUDY FROM THE ICT DEPARTMENT OF ESKOM

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ABSTRACT

Aim/Purpose	The research study investigated opportunities for digital transformation in Eskom's ICT department in the context of the 4IR.
Background	To succeed in business, leaders need to embrace digital transformation as a result of the 4IR.
Methodology	The research study adopted a qualitative interpretive research approach to determine how digital transformation is conceptualized at Eskom's ICT Department in the context of 4IR. Eleven participants consisting of four IT managers, three IT users, two IT Engineers and two IT Executives were interviewed. Semi-structured face-to-face interviews were used to collect research data, which was thereafter analyzed and validated using thematic analysis.
Contribution	The study contributes to an understanding of the 4IR in the context of South African strategic institutions. Such case studies are difficult to access yet are required for educational and improvement purposes.
Findings	Currently, there is no clear guideline to address digital transformation yet the ICT department is expected to take the lead in the digital transformation in the context of the 4IR. Prominent 4IR technologies to support Eskom are Cloud, AI, Big Data and Analytics, Power BI, Power Apps, Blockchain, Digital Workplace, Digital Channels, Agility, IoT, VR/AR. There is nonetheless a fear that 4IR will result in the loss of jobs and cyber risk. Research findings have revealed that digital transformation awareness is required at Eskom.
Recommendations for Practitioners	Intervention strategies such as education and training are critical to the success of the digital transformation initiatives. Upskilling and re-skilling employees on new technologies are essential. Formulation of the digital transformation strategy, adoption strategy, integration plan, stakeholder management and communication plan are key to successful digital transformation at Eskom.
Recommendation for Researchers	The study has shed some light on areas that require attention such as developing a digital transformation strategy and Integration plan to integrate 4IR into the organization. Change management and stakeholder management strategies are also lacking. Researchers need to conduct further studies to address the gap and assist the organization to determine the strategies that will aid Eskom to transform successfully.
Impact on Society	It is envisaged that the 4IR will disrupt the Eskom labor market and contribute to growing income inequalities and unemployment. Awareness, education and training initiatives on 4IR will need to be explored further.

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Future Research Further research can investigate digital transformation on a greater scale within Eskom or any other organization of a similar magnitude especially when considering that the entire organization is being encouraged to participate in digital transformation in the context of the 4IR initiative. Having more participants is needed.

Keywords Fourth Industrial Revolution, Digital Transformation, Cloud, 3D printing, Artificial Intelligence, Internet of Things, Automation, Robotics, Big Data and Analytics

INTRODUCTION

The Fourth Industrial Revolution (4IR) is the fourth major industrial era since the First Industrial Revolution (Effoduh, 2016). It is manifested in all sectors of society including technology, production, consumption and business, thus influencing every field of human life (Li et al., 2017). What differentiates the 4IR from other revolutions is the speed and system impact at which change happens (Xu et al., 2018).

The 4IR presents opportunities to drive social and economic growth and leverage development across all industries and all nations regardless of their location or state of development. This is driven by newer technologies that underpin 4IR such as, but not limited to, 3D printing, robotics, Artificial Intelligence, biotechnology, nanotechnology, and the Internet of Things (IoT). The emergence of 4IR is comprehensive in tackling global challenges using smart meters when compared with previous technologies. While 4IR has the potential of becoming the driving force for social and economic growth, it is anticipated that it will pose major threats to patterns of production, consumption and employment (Ayentimi & Burgess, 2019). In particular, it is envisaged that the 4IR will disrupt the labor market and contribute to growing income inequalities and unemployment (Ayentimi & Burgess, 2019). There are ongoing discussions about the future of the workplace. Pedron (2018) is of the view that 4IR might make jobs redundant and obsolete, however, it will create new ones as well. Although 4IR presents important valuable opportunities for all nations, the impact of 4IR towards emerging economies remain unclear particularly in the African context where there is a large informal economy, limited public transport and low levels of technical skills where technological advancement is found only in a few sectors (Ayentimi & Burgess, 2019).

To ensure sustainable growth, not only should companies take proactive measures to stimulate the economy, governments should be extensively involved in devising policies and strategies to deal with macroeconomic challenges and thus seize opportunities arising from 4IR (Li et al., 2017). To adapt to this changing world and make use of resultant opportunities, ordinary citizens from all sectors of society, industries and economies need to collaborate and formulate comprehensive and shared approaches (NFS, 2018). The companies will also need to keep up with the changes brought by 4IR to stay competitive or they will soon disappear.

The changes brought about by the 4IR are termed as digital transformation. Digital transformation is about doing things differently such as creating new business models and using modern information and technology in various sectors of business and society. Digital transformation leverages existing knowledge to change the essence of the organization, its culture, management strategy, technological mix and operational setup (Savic, 2019). Digital innovation is the main driver of these changes and makes them a reality. It is any digital technology that is perceived as new and requires significant changes to the organization (Fichman, 2014). This research study aims to explore digital transformation in Eskom's Information and Communications Technology (ICT) Department in the context of 4IR.

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PROBLEM STATEMENT

Eskom is a state-owned utility in South Africa whose primary role is to provide uninterrupted supply of electricity to support economic growth and improve on the quality of life for the citizens of South Africa. It is Africa's largest electricity producer, generating approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in the African continent. Eskom is a major driver of the South African economy (The Eskom Factor, 2011). The ICT Department in Eskom is mandated to ensure the effective delivery of Information and Technology (IT) systems, infrastructure and processes to support Eskom's business objectives and business processes (The Eskom Factor, 2011). This research study seeks to investigate the digital transformation in Eskom's ICT Department.

THE STUDY OBJECTIVE

Specifically, this research study seeks to investigate the journey of digital transformation within the ICT Department of Eskom in the context of the Fourth Industrial Revolution (4IR).

RESEARCH QUESTIONS

The objective of this research study seeks to answer the following Primary Research Question (PRQ):

How is digital transformation conceptualized in Eskom's ICT Department in the Context of 4IR?

LITERATURE REVIEW

Fourth Industrial Revolution (4IR)

Schwab (2016) states that the world has experienced four industrial revolutions. The first employed the use of steam engines for mechanical production, the second employed mass production utilizing electricity, the third was characterized by the implementation of the internet and communications technologies to automate production. The fourth one is where the world is witnessing the impact of digital technologies in all sectors across the world, blurring the real world with the technological world (Xu et al., 2018)

The 4IR is a context in which a range of new technologies that combine biological, physical and digital worlds and affects all disciplines, economies and industries, are challenging ideas about what it means to be human (Schwab, 2016). The 4IR is the fusion of all these technologies to create a cyber-physical system (Pil-Sung, 2016). Physical systems can cooperate and communicate with each other and humans in real-time; this is enabled by the IoT and related services (Mcphee et al., 2017). The deeply interconnected world of the technologies is evolving faster than anticipated. What differentiates the 4IR transformation from other revolutions is the velocity, scope and system impact at which it happens.

The 4IR has received much attention in recent years due to the magnitude and speed of an expected disruption and its effects on society. The world is changing and society as a whole is facing fast and radical change due to the rapid advancements of digital technologies and their penetration of all markets (Amorim & Mel, 2013). The 4IR is anticipated to essentially change everything such as industries, economies, jobs, transport, skills and education (Oosthuizen, 2016).

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Integration of technologies and business processes fundamentally change how the organization operates and deliver value to customers (Liu et al., 2011). The speed, breadth, and the depth of the 4IR are forcing humans to rethink how organizations create value and what it means to be human (Mcphee et al., 2017). 4IR is more than a technology-driven change, it is an opportunity to help everyone including leaders, policymakers and people from all income groups including nations to connect the converging technologies and create an inclusive human-centered future. It also helps companies to be more flexible and thus become responsive to business needs and trends (Mcphee et al., 2017).

Prominent 4IR Technologies

4IR is characterized by the convergence of breakthrough technologies such as Advanced Robotics, Artificial Intelligence (AI), IoT, Virtual and Augmented Reality, Quantum Computing, Blockchain and Distributed Ledger Technology as well as 3D printing and these technologies are transforming business production processes and business models across different industries (WEF, 2017). These technologies, which are expected to assist businesses to add value to customers and improve productivity, are explained individually and briefly below.

- **Robotics and Artificial Intelligence (AI)** - The introduction of Robotics and AI has allowed repetitive tasks to be performed by machines so that people can focus on more important activities (Levin, 2018).
- **Internet of things (IoT)** - IoT allows for the tracking of all assets and devices in real-time. Connected devices ensure the availability of real-time data and thus enable the geographic distribution of operations, which results in improvements in operational efficiency, processing time and operational and management costs (WEF, 2017).
- **Virtual and Augmented Reality** - Interfaces between humans and computers involving immersive environments, holographic readouts, and digitally produced overlays for mixed-reality experiences can, among other things, assist with employee training (Levin, 2018).
- **Quantum Computing** - More powerful and exponentially faster than classical computers, quantum computing is capable of dealing with large volumes of complex data.
- **Blockchain and Distributed Ledger** - This is a technology that is based on cryptographic systems that manage, verify and publicly record transaction data (Levin, 2018). This technology can play a major role in departments such as Finance.
- **3D Printing Technology** – Innovation in additive manufacturing involves a wide range of materials and methods including printing plant equipment (Levin, 2018).

The convergence of ICT changes the way people relate with each other thereby changing how human beings live (Chung & Kim, 2016). 4IR mostly affects businesses through transformations in using technologies such as AI, robotics, augmented reality, IoT, autonomous vehicles, 3D printing, nanotechnology, biotechnology, energy storage and quantum computing (Lee & Schwab, 2016). The integration of these technologies into business and production processes makes them more self-sustaining and efficient.

Digital Transformation

There is no common definition of digital transformation but numerous definitions tend to reflect the view of a particular researcher or what it means for a particular business. Digital transformation stems from the evolution of new technologies (Henriette et al., 2015) that are

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referred to as DARQ (Distributed Ledgers, AI, Extended Reality, and Quantum Computing) technologies (Daugherty & Carrel-Billiard, 2019). These new technologies enable major business improvements such as enhancing customer experience, streamlining operations or creating new business models (Amorim & Mel, 2013).

Digital transformation is a strategic decision involving a cultural change within an organization (Andersson & Mattsson, 2015), broadly affecting it in terms of its business model, people, products, processes, and customers. As far as Liu et al. (2011) are concerned, digital transformation is an integration of digital technologies and business processes fundamentally changing how the organization operates and delivers value to customers.

These new technologies impact three organizational dimensions: i) externally enhancing customer experience; ii) internally affecting business operations, decision-making, and organizational structures and iii) holistically, where all areas of business segments and functions are affected leading to an entirely new business model (Ismail et al., 2017).

The external dimension enhances the customer experience digitally. The digital world has empowered organizations to meet customer demands in new improved ways such as developing mobile applications that can be accessed via mobile devices to improve communication to the customer and experience. Von Leipzig et al. (2017) formulated a model called Voice of a Customer. In this model, a customer provides valuable information regarding current products and processes, which may lead to innovative ideas. This customer interaction leads to open collaboration that accelerates innovation using online communities such as mobile and social media (Fitzgerald et al., 2013). Acquired customer insights through digital technologies may assist the business to focus on what the customer needs.

The internal dimension affects business operations, decision-making, and organizational structures. Big data, Analytics and AI can assist organizations to make informed decisions and planning. Rather than waiting for the operator to do routine maintenance of equipment (e.g. in a plant), machine learning can gather data and alert the operator and management based upon real-time data analysis that a certain part needs to be replaced before its failure. Automating operations and standardizing processes can assist organizations to be more agile and be more responsive to changes in demand, which can sustain and increase profitability (Corver & Elkhuizen, 2014).

All parts of the business are affected, leading to an entirely new business model. Most organizations are using Analytics to fundamentally change their products and services (Rosenschein & Krulwich, 2015). This can be achieved through new technologies such as IoT and AI by gathering actual customer behavioral data in real-time instead of historical data. The data gathered using online technologies might assist management to determine the direction the company is taking and that may lead to the creation of a new business model.

RESEARCH METHOD

This study adopted a qualitative interpretive research approach. Eleven employees from Eskom's ICT department were selected using a non-probability purposive sampling method. The sample comprised of Eskom IT users, IT managers, IT engineers and IT executives that were interviewed. Semi-structured face-to-face interviews were used to collect the research data, which was thereafter analyzed and validated. The data collected was analyzed using thematic analysis to identify patterns of themes in the interview data. Thematic Analysis (TA) is an accessible, flexible method of qualitative data analysis for systematically identifying,

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organizing, and offering insights into a pattern or themes across a data set (Braun & Clarke, 2012). The goal of TA is to identify, interpret and makes sense of data patterns to help answer research questions and draw conclusions.

DATA ANALYSIS AND FINDINGS

Eleven participants selected from Eskom's ICT department were analyzed. Purposive sampling method was employed. The selection of participants was based on their knowledge and familiarity with the ICT environment. Table 1 below shows the demographics of participants.

Table 1: 4IR at Eskom: Demographics of Participants.

Participants	Age	Education	Role	Department
IT Engineer 1	32	Certification in IT	IT Support Engineer	Group IT: Desktop Support
IT Engineer 2	28	BTech Degree in IT	IT Engineer	Group IT Application Support
Manager 1	44	BSc in Computer Science	Senior Advisor Information System Applications	Group IT: Applications
Manager 2	38	BSc honors in Computer Science	Service Delivery Manager	Group IT: End User Services
Manager 3	43	BSc in Computer Science	Service Level Manager	Group IT: Service Level Management
Manager 4	46	National Diploma in IT	Senior Advisor: Enterprise Architecture	Group IT Strategy Execution & Architecture (SEA)
IT User 1	34	BCom Degree: Supply Chain	Senior Advisor Procurement	Group Commercial: Supply Chain
IT User 2	50	ND in Human Resources	Senior Advisor: HR	Group HR
IT User 3	41	BCom Financial Management	Middle Manager Finance	Group Finance
IT Executive 1	47	BSc in Computer Science, Management Development Programme	Executive	Group IT Information Management
IT Executive 2	49	MSc Computer Science	Corporate Specialist	Group IT: Strategy Execution & Architecture (SEA)

Research findings revealed the themes and sub-themes that emerged from interview questions. The details of the interviews were recorded transcribed and analyzed and the results that were generated, based on the data collected, are presented in the section that follows.

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HOW IS DIGITAL TRANSFORMATION CONCEPTUALIZED IN THE ICT DEPARTMENT OF ESKOM IN THE CONTEXT OF 4IR? IT ENGINEERS

Table 2 shows that Eskom engineers have an understanding of 4IR and believe that machines will be more powerful in the 4IR era such that they will be as intelligent as human beings are. Some technicians, however, had no idea what the 4IR is. There was also lack of expertise to lead digital initiatives. For example, one IT Engineer remarked:

"*Management has little time to understand these things because they are busy with meetings. They don't have full knowledge of what we are talking about."* There is no digital transformation strategy.

Table 2: 4IR at Eskom: IT Engineers.

Theme	Code	Occurrences
Machines taking over humans	Understanding 4IR: Machines changing how we do things	1
	Understanding 4IR: Machines having intelligence like humans	2
	Total	**3**
Lack of interest	Understanding: No idea	1
Improved Customer Satisfaction	Technologies meeting customer demands: Cloud	1
	Technologies meeting customer demands: AI	1
	Technologies meeting customer demands: VR/AR	1
	Total	**3**
Prominent 4IR Technologies	4IR Technologies: AI	3
	4IR Technologies: Robotics	1
	4IR Technologies: Automation	3
	Total	**7**
Different support skills for different technologies	Required Support Skills: Cloud	1
	Required Support Skills: Technical	2
	Required Support Skills: Training	1
	Total	**4**
Engaged Customers and Employees, Excellent customer service and experience	Benefits: Improving the area of work	3
	Benefits: Easier access	3
	Benefits: Centralized data	1
	Benefits: Agility	1
	Benefits: Self-service	5
	Total	**13**
Lack of expertise to lead a digital initiative	Digital Transformation Top Management: Don't understand	2
Lack of digital transformation Strategy	4IR Forums: Currently there is nothing	1
	4IR Forums: We do not have those in Eskom	1
	4IR Forums: People at the top are the ones attending those forums and taking decisions	1
	Total	**3**

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HOW IS DIGITAL TRANSFORMATION CONCEPTUALIZED IN THE ICT DEPARTMENT OF ESKOM IN THE CONTEXT OF 4IR? IT MANAGERS

Based on Table 3 below, IT managers have an understanding of 4IR. As far as IT managers are concerned, 4IR is the intelligent systems interacting with each other with minimal human assistance. 4IR was understood as changing the way we live and work. However, IT managers believed current jobs will disappear, as machines will take over. Cybersecurity risk will increase due to activities done on the internet. The skills required for digital transformation initiatives are technical and customer management. Digital technology platforms and partnerships will assist Eskom to conduct its business leading to an entirely new business model.

Stakeholder management and communication planning are key to overcome resistance to organizational change. IT managers are also of the view that there is a lack of Top Management support to digital transformation initiative.

Table 3: 4IR at Eskom: IT Managers.

Theme	Code	Occurrences
Intelligent Systems interacting with each other with minimal human assistance	Understanding 4IR: Automation of processes.	1
	Understanding 4IR: Machines talking to each other no human intervention.	1
	Understanding 4IR: Systems more Intelligent.	1
	Understanding 4IR: Digitalization.	1
	Understanding4IR: Combine things, processes and things with analytics.	1
	Understanding 4IR: IoT.	1
	Total	**6**
Invalidate existing jobs	4IR Disadvantage: Loss of jobs.	1
Cyber risk	4IR Disadvantage: Internet not safe.	1
Improved Customer service and experience	4IR Tech Customer Service: Chatbots.	1
	4IR Tech Customer Service: Analytics Power BI.	3
	4IR Tech Customer Service: Self Service.	1
	4IR Tech Customer Experience: IoT.	1
	4IR Tech Customer Experience: Cloud.	5
	4IR Tech Customer Experience: Real-time data.	2
	4IR Tech Customer Demands: Robotics.	1
	Total	**14**

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Theme	Code	Occurrences
Prominent 4IR Technologies	4IR Tech for Eskom: Cybersecurity	1
	4IR Tech for Eskom: AI.	3
	4IR Tech for Eskom: Blockchain.	1
	4IR Tech for Eskom: Power Apps.	1
	4IR Tech for Eskom: IoT.	1
	Total	**7**
Technical and Customer Management skills	Skills Required: Technical Support Skills.	1
	Skills Required: Service Level Management.	1
	Skills Required: To Build Power Apps.	1
	Skills Required: Retraining.	1
	Skills Required: Cybersecurity and Cryptography.	1
	Total	**5**
Process information faster resulting in quicker decision making and improved performance in activities	Benefits: Assist in Decision making.	1
	Benefits: Real-time information.	1
	Benefits: Creation of apps in a week.	1
	Benefits: fewer Incidents of death.	1
	Benefits: Agility.	1
	Total	**5**
Digital technology platforms and partnerships	Tech News Business Model: Ecosystem sharing of resources.	1
	Tech New Business Model: Digital Platform.	1
	Tech New business Model: Collaboration with other SOEs.	1
	Total	**3**
Digital Transformation Strategy Exists	4IR Strategy: There is a strategy.	1
	4IR Strategy: There is a strategy.	1
	4IR Strategy: There is a strategy.	1
	4IR Strategy: There is a strategy.	1
	Total	**4**
Lack of digital transformation execution	Adoption 4IR Strategy: New adoption of the strategy needs to be considered.	1
	Adoption 4IR Strategy: it is not communicated and not implementable. It is vague, no plan no KPIs.	1
	Total	**2**

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Theme	Code	Occurrences
Stakeholders management and communication plan	Overcome Resistance to Organizational Change: Partner with Business.	1
	Overcome Resistance to Organizational Change: Consultation and Engagement with stakeholders.	1
	Overcome Resistance to Organizational Change: Communication with all stakeholders.	2
	Total	**4**
Lack of expertise to lead digital transformation initiative	DT understanding by Top Management: Don't know.	1
	Digital Transformation Understanding Management: No Understanding.	1
	DT understanding by Top Management: They do not have full knowledge of what we are talking about.	1
	DT understanding by Top Management: Very few people know. Implementers do not know.	1
	Total	**4**

HOW IS DIGITAL TRANSFORMATION CONCEPTUALIZED IN THE ICT DEPARTMENT OF ESKOM IN THE CONTEXT OF 4IR? IT USERS

Based on the results presented in Table 4, Eskom IT users have a limited understanding of 4IR. Although the users have indicated reading about 4IR, they still struggle to understand what the concept is all about. In addition, some IT users believe 4IR is not applicable to South Africa. For example, one user comment was as follows: “4IR is not for South Africa”.

Table 4: 4IR at Eskom: IT Users.

Theme	Code	Occurrences
New technologies changing the way we live, interact and work	Understanding 4IR: Automation process across Industries.	1
	Understanding 4IR: Technology running our lives.	1
	Total	**2**
Lack of knowledge	Understanding: Read about it but no idea what is it about.	1
Improved Productivity and Flexibility	4IR Tech Customers and Employees: Automation.	4
	4IR Tech Customer and Employees: Openness and Visibility.	1
	4IR Tech Improving Customer Experience: Access Information wherever you are.	1
	4IR Tech meeting Customer Demands: Blockchain.	1
	Total	**7**
Lot of manual work	4IR Technology Challenges in meeting Customer Demands: Won't help.	2

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Theme	Code	Occurrences
Prominent 4IR Technologies	4IR Tech: Data Analytics.	3
	4IR Tech: Digitalization.	1
	4IR Tech: Blockchain.	1
	Total	**4**
4IR for other countries	4IR is not for South Africa.	1
Interpersonal Skills	Digital Innovation Support Required: Change Management.	1
	Digital Innovation Support Required: Creating Dashboards.	1
	Digital Innovation Support Required: Creating Dashboards.	2
	Total	**4**
Efficiency and Improved productivity	Benefits: Technology simplifying lives.	1
	Benefits: Data readily available on dashboards.	1
	Benefits: Documents not altered and visible.	1
	Benefits: Data analyzed and simplified.	1
	Benefits: Continuity.	1
	Benefits: Assists with Collaboration.	1
Lack of digital transformation strategy	Forums to discuss DT initiatives: No, we do not have any structure or meetings.	1
	Forums to discuss DT initiatives: No, we do not have any structure.	1
	Forums to discuss DT initiatives: No nothing is discussed in my meetings.	1
	Total	**3**
Lack of adoption strategy	Threats if not using the new systems.	1
Lack of expertise to lead digital transformation initiative	Digital Transformation Understanding Management: No Understanding.	1
	DT understanding by Top Management: They don't have full knowledge of what we are talking about.	1
	DT understanding by Top Management: Do not think so.	1
	Total	**3**

HOW IS DIGITAL TRANSFORMATION CONCEPTUALIZED IN THE ICT DEPARTMENT OF ESKOM IN THE CONTEXT OF 4IR? IT EXECUTIVES

The data collected in Table 5 suggests that IT Executives have a greater and better understanding of 4IR and they view 4IR as a technological innovation and digital transformation that will change how people live and work. For example, one executive commented: "*4IR is not about technology it is a new way of living. It is a new corporate altogether*"

Technologies such as Power BI, Digital Workplace, Cloud, and AI will result in improved operational efficiency, revenue growth, cost-saving, and better customer service.

Technical and Interpersonal skills such as ideation, agile initiatives, technical skills, DevOps, Design Thinking, Data Scientists, Coding, Contract Management Skills and Customer Relations are also needed for 4IR to be successful. Constant change management and executive support is needed to overcome resistance to organizational change. However, lack

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of digital transformation strategy and expertise and a commitment to lead digital initiatives is of grave concern. To this end, a digital transformation plan is needed.

Table 5: 4IR at Eskom: IT Executives.

Theme	Code	Occurrences
Technological innovation and transformation changing the way we live and work	Understanding: Combination of technologies directing business.	1
	Understanding: DT change business model, processes and services offered.	1
	Understanding 4IR: DT blurring physical, biological and digital spheres.	1
	Understanding: technology era we are in.	1
	Understanding: Brings disruptive technologies.	1
	Total	**5**
Improved operational efficiency, revenue growth, and better service	4IR Tech cost-saving and efficiency: Power BI.	1
	4IR Tech cost-saving and efficiency: Digital Workplace.	1
	4IR Tech cost-saving and efficiency: Cloud.	2
	4IR Tech cost-saving and efficiency: AI.	1
	4IR Tech cost-saving and efficiency: Power Apps.	1
	Total	**6**
Faster response to customer needs and Improved customer experience	4IR Tech Meeting customer demands: Combination of technologies.	1
	4IR Tech Customer Experience: Self-booking.	1
	4IR Tech meeting customer demands: Analytics and Big Data.	1
	4IR Tech Meeting Customer Demands: Agility.	1
	4IR tech customer experience: Digital channels.	1
	4IR Tech customer experience: customer engagement platforms.	1
	Total	**6**
Empowered users and Improved teamwork, collaboration, and productivity	IT Executive 4IR Tech Improving team performance: Power BI.	2
	IT Executive 4IR Tech Improving team performance and policies: O365.	1
	IT Executive 4IR Tech Improving team performance: Microsoft Teams.	2
	Total	**5**

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Theme	Code	Occurrences
Technical and Interpersonal Skills.	Skills Required: Ideation.	1
	Skills Required: Agile Initiatives.	1
	Skills Required: Technical Skills.	2
	Skills Required: DevOps.	1
	Skills Required: Design Thinking.	1
	Skills Required: Depends on Technology being used.	1
	Skills required: Data Scientists.	1
	Skills Required: Coding.	1
	Skills required: Contract Management Skills.	1
	Skills required: Customer relations.	1
	Total	**11**
Engaged Employees and Customers, Improved productivity, profitability, and quality	4IR Benefits: VR and AR for power station employees.	1
	4IR Benefits: Self Service.	1
	4IR Benefits: Predictive Maintenance simpler.	1
	4IR Benefits: Connect anywhere anytime.	1
	4IR Benefits: Collaboration.	1
	4IR Benefits: Improve communication.	1
	Total	**6**
Flexible working hours, changes in policies and culture change	Tech News Business Model: Time shouldn't be the thing of going 8 to 4.	1
	Tech News Business Model: Increased mobility such as working from anywhere remotely.	1
	Tech New Business Model: The whole culture change and a more focused effort on digital transformation.	1
	Tech News Business Model: 4IR is not about technology it is a new way of living. Policies and procedures need to change. It is a new corporate altogether.	1
	Total	**4**
Lack of DT Strategy	4IR Strategy: Not yet.	1
	4IR Strategy: No, there is not.	1
	Total	**2**
Formulate digital transformation execution plan	Adoption 4IR Strategy: Need for Innovative mechanism.	1
	IT Executive Adoption Strategy: IT needs to promote these technologies.	1
	Total	**2**
Executive support and constant change management	Overcome Resistance to Change: Constant Change management.	1
	Overcome Resistance to Change: Top Management Buy-in.	1
	Total	**2**

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Theme	Code	Occurrences
Lack of expertise and commitment to lead digital transformation initiative	DT understanding by Top Management: No, we do not.	1
	DT understanding by Top Management: No in general.	1
	DT understanding by Top Management: No commitment from executives.	1
	Total	**3**

RECOMMENDATION

The research findings have revealed that digital transformation awareness is required at Eskom and intervention strategies such as education and training are critical to the success of the digital transformation initiative. Upskilling and re-skilling employees on new technologies are essential. Formulation of digital transformation strategy, adoption strategy, integration plan, stakeholder management and communication plan are key to successful digital transformation at Eskom.

RESEARCH STUDY LIMITATION

The study limitation is related to the sample size of 11 Eskom ICT employees who participated. Eskom is a big organization, and the sample size is relatively small, especially considering that the entire organization is encouraged to participate in the digital transformation in the context of the 4IR initiative. The availability of the participants was also a challenge since the data collection process was undertaken towards the end of the year. Most participants were either on leave or busy closing down projects in fulfilment of the year-end requirements.

FUTURE RESEARCH

Further research should investigate digital transformation on a greater scale within Eskom or any other organization of a similar magnitude. Having more participants might yield better results.

CONCLUSION

The objective of this paper was to investigate the journey of digital transformation within Eskom's ICT department in the context of the Fourth Industrial Revolution. The primary research question was how digital transformation is conceptualized in the ICT department of Eskom in the context of 4IR. Research objectives were addressed using qualitative methods. Research findings revealed that the attitudes of Eskom employees towards 4IR is very optimistic but more still needs to be done in terms of awareness creation, education, and training.

There is an opportunity to implement prominent 4IR technologies such as Cloud, AI, Big Data and Analytics, Power BI, Power Apps, Block-chain, Digital Workplace, Digital Channels, Agility, IoT, VR/AR, which will enable employees to be more efficient and lead to improved customer experience. Automation could give Eskom employees time to focus on high-value tasks such as problem-solving and developing new ideas.

The emergence of new business models incorporating digital technology platforms and partnerships will stimulate diverse ecosystems of participants and deliver value to customers.

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This will also enable policymakers to make decisions that would positively enhance the Eskom's ICT Department.

The skills needed in Eskom to support 4IR innovations are technical, interpersonal and customer management skills. Employees need to be trained or reskilled to have the required skills.

The study has shed some light on areas that require attention such as developing a digital transformation strategy and an integration plan to integrate 4IR into the organization. Change management and stakeholder management strategies are also lacking. There appears to be lack of commitment or expertise from top executives to drive digital transformation initiatives. Using advanced technologies could help solve pressing organizational challenges such as storing electricity.

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REFERENCES

Amorim, M. & Mel, N. (2013). Advances in Information Systems and Technologies, 206, p.411–421. doi: 10.1007/978-3-642-36981-0.

Andersson, P E R, & Rosenqvist, C. (2016). WEF Report: World Economic Forum White Paper: Digital

Transformation of Industries: Digital Enterprise. Strategic Challenges of Digital Innovation and Transformation, p. 17-40

Ayentimi, D. T. & Burgess, J. (2019). Is the fourth industrial revolution relevant to sub-Sahara Africa?, Technology Analysis and Strategic Management. Taylor & Francis, 31 (6), p. 641–652. doi: 10.1080/09537325.2018.1542129.

Braun, V. & Clarke, V. (2012). Chapter 4: Thematic Analysis, APA Handbook of Research Methods in Psychology, 2, p. 57–71. doi: 10.1037/13620-004.

Chung, M. & Kim, J. (2016). The Internet Information and Technology Research Directions based on the Fourth Industrial Revolution, 10 (3), p. 1311–1320.

Corver, Q. & Elkhuizen, G. (2014). A Framework for Digital Business Transformation, Cognizant, p. 1–10. https://www.cognizant.com/InsightsWhitepapers/a-framework-for-digital-businesstransformation-codex-1048.pdf.

Daugherty, P. & Carrel-Billiard, M. (2019). ARE YOU READY FOR WHAT'S NEXT? The Post-Digital READY FOR WHAT'S NEXT?, Techvision 2019. Available at: https://www.accenture.com/_acnmedia/PDF-94/Accenture-TechVision-2019-Tech-Trends-Report.pdf.

Effoduh, J. O. (2016). The Fourth Industrial Revolution by Klaus Schwab, in The Transnational Human Rights Review, p. 2–10.

Eskom Holding Limited. (2011). The Eskom Factor.

http://www.eskom.co.za/OurCompany/SustainableDevelopment/Documents/EskomFactor.pdf

Fichman, R. G. (2014). DIGITAL INNOVATION AS A FUNDAMENTAL AND POWERFUL CONCEPT IN THE INFORMATION SYSTEMS CURRICULUM 1, 38 (2), p. 329–353.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Fitzgerald, M. et al. (2013). Embracing Digital Technology: A New Strategic Imperative | Capgemini Consulting Worldwide, MITSloan Management Review, p. 16. Available at: https://www.capgeminiconsulting.com/SMR.

Henriette, E., Feki, M., & Boughzala, I. (2015). The shape of digital transformation: a systematic literature review. In: Information Systems in a Changing Economy and Society, p. 431.

Ismail, M. H., Khater, M. & Zaki, M. (2017). Digital Business Transformation and Strategy: What Do We Know So Far?, Cambridge Service Alliance, (November 2017), p. 36. doi: 10.13140/RG.2.2.36492.62086.

Klaus, S. (2016). The Fourth Industrial Revolution: what it means and how to respond, World Economic Forum, (January), p.1–8. Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrialrevolution-what-it-means-and-how-to-respond/.

Levin, S. (2018). Trade and Industry Policy Strategies. Available at: www.tips.org.za.

Li, G., Hou, Y. & Wu, A. (2017). Fourth Industrial Revolution: technological drivers, impacts and coping methods, Chinese Geographical Science, 27 (4), p. 626–637. doi: 10.1007/s11769-017-0890-x.

Liu, D., Y., Chen, S., W. & Chou, T., C., (2011). Resource fit in digital transformation: Lessons learned from the CBC Bank global e-banking project. Management Decision, 49 (10), pp.1728–1742.

Mcphee, C., Hudson, D. & Allahar, H. (2017). Technology Innovation Management Review Editorial Insights, 7 (11).

NFS (2018). Discussion Forum: The 4th Industrial Revolution, in Implications of the 4th Industrial Revolution for SET, industry, society, and education, p. 11–13.

Oosthuizen, J. (2016). An Assessment of 4IR-Intelligence of South African Management Practitioners Through the Lens of the Fourth Industrial Revolution. (September), pp.4-6.

Pedron, Z. (2018). THE SKILLS REVOLUTION OF THE 21ST CENTURY: IT'S TIME TO RECALIBRATE, Journal of EU Business School, 1, pp. 20–28.

Rosenschein, J. S. & Krulwich, B. (2015). Revamping Your Business Through Digital Transformation, Contract, p. 1–6. doi: 10.1108/10878571211209314.

Savic, D. (2019). From Digitization, through Digitalization, to Digital Transformation, Online Searcher, (January), p. 37–39.

Von Leipzig, T., Gamp, M., Manz, D., Schöttle, K., Ohlhausen, P., Oosthuizen, Von Leipzig, K. (2017).

Initializing customer-orientated digital transformation in enterprises. Procedia Manufacturing, 8, pp.517–524.

WEF (2017) Impact of the Fourth Industrial Revolution on Supply Chains.

Xu, M., David, J. M. & Kim, S. H. (2018). The Fourth Industrial Revolution: Opportunities and Challenges, 9 (2), p. 90–95. doi: 10.5430/ijfr.v9n2p90.

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APPENDIX A

Interview Protocol				
Sub-Research Questions	**Interview Questions Prepared For: Eskom IT Employees**			
	Users (Eskom employees)	IT (Engineers)	IT Manager	Executive Management
SR1: Which 4IR technologies are most applicable to Eskom's IT department?	How do you understand the 4IR?	How do you understand the 4IR?	How do you understand the 4IR?	How do you understand the 4IR?
	Which 4IR technologies are useful in your work environment?	Which 4IR technology is appropriate for Eskom IT?	Which 4IR technology is Applicable to Eskom IT department?	What 4IR technologies are needed in Eskom to improve savings, and improve efficiency of employees?
SR2: What are the potential benefits of 4IR technologies to Eskom's IT department?	What are the potential benefits that the 4IR technology would bring if implemented?	What benefits will 4IR technology bring to improve your area of work?	What are the potential benefits that 4IR technology would bring improve the work of IT?	What is the potential benefits of 4IR technology that would improve the efficiency of Eskom?
SR3: Which 4IR technologies has the IT department of Eskom considered for employees and customers	Which 4IR technologies would enable you to connect better with your customers and fellow employees	Which 4IR technologies would enable you to service your customers and fellow employees?	Which 4IR technologies can be considered to better service employees and customers in Eskom IT	Which 4IR technologies can be considered to enhance employees and customer experience
SR4: To what extent has the ICT department of Eskom digitally enhanced the customer experience?	To what extent has IT implemented digital innovations to help improve customer collaboration and experience?	To what extent has IT implemented digital innovations to enhance customer experience?	Which 4IR technology has been considered to enhance customer experience?	Which 4IR technology may assist the business to focus on what the customer needs?
SR5: To what extent is the IT department of Eskom considering new technologies that will internally affect business operations, products and processes?	To what extent has IT implemented technologies that are capable of improving how you conduct your work?	To what extent has IT considered digital technologies to improve your daily functions?	Which digital technologies are considered to improve IT processes, decision making and operations?	Which digital technologies have been considered to improve team performance, processes, policy and operations?

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Interview Protocol (Continued)				
Sub-Research Questions	**Interview Questions Prepared For: Eskom IT Employees**			
	Users (Eskom employees)	IT (Engineers)	IT Manager	Executive Management
SR6: To what extent is Eskom ICT department considering new technologies affecting all business segments and functions leading to an entirely new business model?	To What extent have new technologies changed how you perform your work?	To what extent have newer technologies changed how you conduct business and support customers?	To what extent have newer technologies been considered in a way to change how business is conducted leading to entirely new business model?	To what extent will the newer technologies change the way the team operates affecting all business segments and functions?
SR7: Do Eskom IT department consider adopting new technologies to meet customer demands?	What newer technologies can be adopted to help with challenges in meeting customer demands?	What 4IR technologies can be adopted in IT to overcome customer demands?	What 4IR technology can Eskom IT adopt to meet customer demands	What 4IR technology can Eskom adopt to support employees meet to customer demands
SR8: What is the strategy for adoption of new digital innovations in the IT department of Eskom?	Are there meetings advocating new digital technologies in your area of work?	Are there structures for adopting new digital innovation suitable for IT in Eskom?	Is there a strategy to support adoption of digital innovations?	Is there a structure formulated to assist employees to adopt digital innovations?
SR9: What new skills are needed in Eskom ICT department to support new digital innovations?	What support would you require for new digital innovations?	What skills do you require to support new digital innovations?	What skills and resources are needed to support 4IR /digital innovations technologies	What skills do employees require for new 4IR digital innovations
SR10: How do management understand digital transformation as it affects Eskom?	How do management understand digital transformation as it affects Eskom	How do management understand digital transformation as it affects Eskom	Do management have enough information to fully understand the importance of digital transformation?	Do management have enough information to fully understand the importance of digital transformation?
SR11: How is IT department of Eskom planning to overcome resistance to organizational change?	How willing are you to embrace these digital technologies	How willing are you to embrace these digital technologies?	How is IT department of Eskom planning to overcome resistance to organizational change?	How is Eskom planning to overcome resistance to organizational change?

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EXPERIENCES AND REFLECTIONS OF PRINCIPALS AND TEACHERS ON THE USE OF EDUCATIONAL TECHNOLOGY IN THE SELECTED RURAL MOPANI-LIMPOPO SCHOOL IN SOUTH AFRICA

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ABSTRACT

Aim/Purpose	The paper reports on the study that examined experiences and reflections of principals and teachers on the use of educational technology in selected rural schools in the Mopani District of Limpopo, South Africa.
Background	The problem faced by Limpopo schools in Mopani District is lack of modern educational classroom technology and lack of ICT infrastructure in these schools. Furthermore, teachers lack the digital skills required for transitioning from a traditional to a digital pedagogy.
Methodology	This study is premised within the interpretivism paradigm that informed the use of interviews and observations qualitative research design. Four secondary schools were purposively selected; and four principals and eight teachers served as research participants.
Contribution	This paper contributes knowledge of the educational technology provisioning in rural Limpopo schools; and the positive and negative impact of such technologies on teaching and learning.
Findings	The research findings revealed a lack of modern educational technology in schools in the Mopani District of the Limpopo Province, with subsequent minimal usage levels. Secondly, the positive effects of modern technology on teaching and learning were found to enhance student learning and improve student engagement; resulting in improved learners results. Technology addresses multiple learning problems such as learning at different paces using different learning styles. Lastly, setbacks revealed in this study include lack of focus (minimal teacher and learner interaction) because learners are distracted by social media. Learners and to lesser extent, teachers, experience cyber bullying. Unfortunately, teachers still lack digital skills and pedagogies.
Recommendations for Practitioners	This study recommends that the Department should provide digital technologies to schools as well as digital training and support teachers who still lag behind.
Recommendation for Researchers	Large-scale research should be conducted on teachers' digital skill levels and the use of digital pedagogies in rural schools in Mopani in order to establish the level of preparedness by teachers to venture into the digital teaching space. Research should further establish the level of educational technologies provisioning, ICT infrastructure available and the types of classroom technologies available in such schools.

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Impact on Society	This paper will be an eye opener to Mopani community on the level of educational technology use, ICT infrastructure available, and level of teachers' readiness to use modern educational technologies.
Future Research	To examine how teachers can be prepared to venture into the 21st Century using digital pedagogies and seek strategies that will ensure provisioning of classroom technology and the required ICT infrastructure in schools.
Keywords	Educational Technology, Digital Skills, Digital Pedagogy, Student Learning

INTRODUCTION AND BACKGROUND

"Technology can be a powerful tool for transforming learning. It can help, affirm and advance relationships between educators and students, reinvent our approaches to learning and collaboration, shrink long-standing equity and accessibility gaps, and adapt learning experiences to meet the needs of all learners" (U.S. Department of Education, 2017).

The value of Educational Technology (E-Tech) is put in perspective by the U.S. Secretary of Education, John King when he highlighted three crucial issues of digital learning, namely, equity, accessibility and inclusivity.

This paper aims to examine the experiences and reflections of principals and teachers on the use of educational technology in selected rural Limpopo schools in South Africa. The introduction and integration of technology for teaching and learning is very crucial to the South African Education Ministry as reflected by the formulation of an e-Education Policy in 2004. The e-Education Policy aims to guide technology introduction and integration in education. However, fourteen years after the policy formulation, schools are still faced with inadequate provisioning of ICT infrastructure and classroom technology that should be driving implementation of this policy and subsequent achievements of its aims and objectives. The majority of public schools were left to fend for themselves as the schools were not supplied with the required educational technology and information and communication technological infrastructure to make policy implementation possible. A key challenge to provisioning of ICT infrastructure and connectivity in schools and the introduction of classroom technology was identified as budget constraints (Department of Education, 2016). Surprisingly, the Gauteng Department of Education is able to provide learners with access to engaging materials that are interactive, adaptive, comprehensive and improve independent learning (Gauteng Department of Education, 2016).

Apart from the e-Education policy, the zeal for integration of technology for teaching and learning has coerced the Department of Basic Education (DBE) into the adoption of various policies, frameworks and strategies to drive this intention. Teacher development initiative and ICT integration for teaching and learning were central to initiatives such as "Action Plan to 2019: Towards realization of schooling", "National Strategy for learner attainment 2015"; and "South African Council of Educators (SACE)". These initiatives and institutions believe and support the notion that ICT creates space for improved teaching and learning. In support, Ramorola (2010) refers to E-tech as "new opportunities that make teaching more meaningful and rewarding". In 2018, the "Professional Development Framework for Digital Learning" was adopted as a guide to teacher's digital learning (DBE, 2018). Unlike in other provinces such as Gauteng and Kwa-Zulu Natal, the Limpopo Province has a Co-Lab School Project as the only active E-Tech project aimed at equipping and re-skilling principals and teachers on the use of E-Tech in the classroom. The majority of schools in Mopani within the Limpopo Province are dysfunctional, particularly on the basis of technology. Research reveals the existence of a

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new digital divide in that some learners are exposed to more digital learning benefits more than others (U.S. Department of Education, 2017).

PROBLEM STATEMENT

Despite DBE's intentions to integrate technology into teaching and learning, little has been done on E-tech and ICT infrastructure provisioning, and training of teachers on computer and digital skills. According to Ndlovu and Lawrence (2012), the DBE rolled-out computer provisioning to schools with the intention to use "computers to strengthen teaching and learning and to redress past inequities". The problem this paper investigates is to examine experiences and reflections of principals and teachers on the use of educational technology in selected rural Limpopo schools in South Africa. This study reiterates two primary challenges that compromise the integration of technology and the use of E-Tech in South African rural public schools, namely, limited E-Tech resources and lack of ICT infrastructure; as well as lack of computer and digital skills among teachers. Lack of E-Tech and ICT infrastructural provisioning (Lekgothoane & Thaba-Nkadimene, 2019; Pholotho & Mtsweni, 2016; Hannaway, 2016; Ndlovu & Lawrence, 2012) is a primary setback for teachers who want to venture into 21st Century teaching. Sixteen years after the promulgation of e-Education policy in 2004, schools still lack crucial resources and the infrastructure required to venture into 21st Century teaching. Limitation on the part of teachers with respect to computer and digital skills (Lekgothoane & Thaba-Nkadimene, 2019; Hannaway, 2016) is a setback that requires the DBE to provide adequate computer and digital training for serving teachers.

The majority of public schools, particularly in rural black South African communities, are still sidelined with respect to the allocation and provisioning of 21st Century strategic school resources, namely, E-Tech and ICT infrastructure by non-governmental organizations and the private sector. The unfair provisioning widens the schools' resource-based gaps that perpetuate inequities and equalities among South African public schools. In South Africa, we still complain of E-Tech and ICT infrastructure provisioning, whereas, European communities have moved on and passed provisioning and implementation stages; they are at the stage of evaluation of effectiveness of digital and online learning. The European Union and its agencies have currently embarked on a "Digital Skills and Competence (DSC) and Digital and Online Learning (DOL)" programme (Brolpito, 2018), while the majority of South African schools (80%) were declared dysfunctional by Spaull in 2012 are still at initial levels of digital learning. The blame for the current low levels of technology penetration in schools; the low levels of digital learning; and backlog in the provisioning of E-Tech and ICT infrastructure in schools should be leveled at the DBE and at the State.

LITERATURE REVIEW

The definition of educational technology has evolved through ages and we find it worthwhile to trace its meaning, and to undergird this paper on one selected definition. In the conceptual stages, educational technology was conceived as theory, practice and design, as well as communication that developed learners' capacities and potential (Januszewski, 2008). Education technology was further defined as the "art and study of building a learning system as well as setting a feedback mechanism from learning system". In this study, a recent definition of education technology is adopted and it defines E-Tech as a dynamic system of study and moral action with the aim of specifying and providing an interactive environment for learners' activity for the fast, easy, durable education and learning in harmony with their interests and characteristic (Ahmadigol, 2016).

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The value of educational technology lies with its potential to provide a digital learning space that is active, advanced and interactive. The effective use of E-tech can "translate teaching into effective learning by providing learners with new possibilities for exploration" (Alavati, 2016). In this study, the researchers strongly believe that the implementation of E-Tech and the training of educators has capacity to improve student learning and academic achievement. Therefore, there is a need to change from a traditional to a digital learning space. We understand that this change requires transformation of our understanding of the learning processes and how learning takes place. It equally requires teachers to be at a certain level of digital literacy and for them to be prepared to venture into a digital learning space. This digital learning space "motivates learners and promote learning, supports collaborations and individualized learning and its flexible and responsive to changing needs" (JISC e-Space Study, 2005). New connective technologies create digital learning spaces wherein "schools can create more expansive conditions from where kids can learn, effectively enlarging those conditions to include a mixture of spaces that can support learning in a typical physical classroom, online, and in a blend of both spaces" (Jakes, 2015). Once the digital learning space is addressed, teachers and learners' digital literacies becomes the next crucial factor to consider for effective digital learning. Digital literacy refers to ability to comprehend digital tools and resources in order to live in a digital society (DBE, 2018). The Professional Development Framework for Digital Learning further highlights that digital literacy encompasses "ICT literacy, information literacy, media literacy and digital citizenship" (DBE, 2018). NEMISA (2020) defines digital literacy as "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".

The added-values associated with educational technologies encouraged education ministries around the world to transition to E-Tech. Countries that are left behind deny schools under their jurisdiction opportunities to tap into the vast benefits that are bought about by the introduction of such technologies. Five of such benefits are by mentioned by Savvidid (2020) as *i) improved knowledge retention, ii) encourages individual learning, iii) encourages collaboration, iv) students learn useful life skills through technology and v) improve teaching.* Despite the great benefits and value of the introduction of technology to teaching and learning, such introduction can also result in multiple setbacks caused by the integration of technology in education, namely, *"immense expenditures, insufficient methods of teaching, increased rate of cyber bullying, creating enough room for cheating, major sources of distractions and waste of valuable time, transforming learners into inefficient learners"* (University Homework Help, 2015).

South African public schools that were required to implement the e-Education Policy in 2004 were not adequately supported with connectivity and device access, which resulted in minimal and little use of classroom technology to improve teaching and learning (Blignaut et al., 2010). The South African Government did not succeed in addressing the immense expenditure required to make e-Education Policy implementation possible. Research reveals a lack of educational resources in schools, teachers' preference to using traditional pedagogies over digital pedagogies and stringent working conditions that make it difficult for teachers to venture into digital spaces because they are denied access to the educational technologies required for 21st Century teaching and learning (Lekgothoane & Thaba-Nkadimene, 2019).

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THEORETICAL FRAMEWORK

The study used the "Professional Development Framework on Digital Learning" (DBE, 2018) as the conceptual framework that guided the formulation of two research questions; namely, what are the principals and teachers' experiences and reflections on the use of educational technology? What do they think are benefits and challenges of such digital technologies? The top three "Educator Digital Learning Proficiencies/Competencies" as outlined in the Framework (DBE, 2018) were used, namely:

1. "Adopt the habit of an enquiring mind regarding the educational value of using digital tools and resources",
2. "Be reflective about challenging current digital learning and teaching practice",
3. "Understand the role of the teacher, the learner and the digital resources during learning".

RESEARCH DESIGN

This study is premised within interpretivist paradigm that informed the use of an interview qualitative research design. The interpretivist paradigm is used to understand contemporary social reality (Chowdhury, 2014), in this case, the use of E-Tech that needs to be understood and examined through multiple perspectives. Four secondary schools were purposively selected while four principals and eight teachers served as research participants. Furthermore, the research participants' lived experiences and reflections of the principals and teachers' usage of E-Tech as social reality is understood and examined within their school context (Thanh & Thanh, 2015; Creswell, 2007). Data was collected using interviews and observation qualitative designs.

RESEARCH FINDINGS

The research findings revealed an inadequate educational technological provisioning in Mopani schools (Limpopo Province) with consequent minimal usage levels by principals and teachers. This finding emerged from the research question, "what are principals and teachers' experiences and reflections on the use of educational technology?"

The availability and accessibility of educational technologies promotes their usage in teaching, learning and administration. Furthermore, their availability and accessibility create opportunities for a transition from traditional classrooms to digital classrooms. In support of the significance of technology's availability and accessibility, El-Hussein and Cronje (2010) emphasize the value of technology provisioning in schools, and argue that "knowledge creation and sharing in the modern world is transformed by the development of revolutionary technologies in society, such as pedagogical technologies". In addition, UNESCO (2011) stresses that "the penetration of E-Tech in education can eventually transform pedagogy and the creation of knowledge".

While the DBE formulated an e-Education policy in 2004, it was not successfully accompanied and supported by the provisioning of the required levels of digital classroom technologies in South African public schools. The challenge of inadequacies in technological supply was raised by studies that were conducted in previously disadvantaged rural public schools (Lekgothoane & Thaba-Nkadimene, 2019). Instead, the Department shifted this responsibility to non-government organizations and private sector and in 2016, Vodacom responded to this call and supplied tablets to Grade 12 learners in the Gauteng Province. There was never such a large-scale initiative implemented in deep rural provinces such as the Limpopo Province. This has created a digital learning gap in the South African education system, which is widening annually. In examining this digital learning divide or gap, the 20/80 divide revealed

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by Spaull (2012) in terms of school's functionality is used. Figure 1 below which displays digital learning divide.

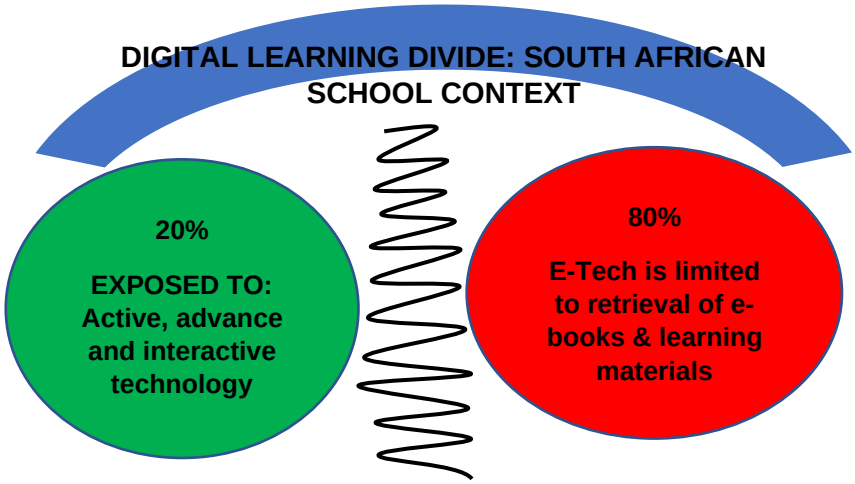

Figure 1: Digital Learning Divide: South African School Context.

Figure 1 exhibits digital learning divide within the South African school context. The examination of the gap used Spaull's 2012 model which shows 20% of South African schools are equipped with active, advanced and interactive technology that allows schools to venture into digital learning space, while 80% of schools in the country make minimal use of educational technology for retrieving e-learning books and learning materials. The majority of South African children receive their education in these schools that are deprived of strategic school resources. Unlike in the USA with fewer schools that are disadvantaged (U.S. Department of Education, 2017), the majority of children in South Africa receive their education from technology-deprived public schools. In simple terms, the difference between the USA and South Africa is that a significant number of students (80%) are denied access to interactive digital technology. Operation Phakisa that was driving National Vision for ICT did not make any impact on schools in the rural Mopani District in Limpopo Province. It failed to carry its mandate which was to focus on rural schools because of their exclusion from previous school connectivity programmes (DBE, 2016). These schools are still the same as they were in 2004 when ICT was introduced and in 2016 when the focus of connectivity of schools was directed at rural schools. These schools have experienced double exclusion from these large-scale DBE initiatives. The exclusion of these schools through the negligence of the DBE contravenes the children's constitutional right to quality education and hampers the drive towards social transformation, equality and social justice, which become a far-fetched goal.

Due to lack of digital classroom technologies in schools, a follow-up question was raised on what principals and teachers think are benefits of and challenges associated with the use digital technologies? The responses of principals and teachers indicate that they agree that E-Tech can improve student learning, improve student engagement and improve learners' results. Attainment of such education objectives is driven by the fact that "technology shifts the way students learn, through interactive, media-rich and exciting digital environments" (Montrieux et al., 2015).

Apart from the positive effects of E-Tech in classrooms, the study has further revealed a set of setbacks. The first setback was lack of focus from learners with minimal teacher-learner interaction and learner-learner interaction because learners were distracted by social media when operating their hand-held E-Tech gadgets. Learner distraction was found to be the main setback of E-Tech in classrooms (Universityhomeworkhelp.com, 2015). The second setback

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was found to be learners' experience of cyberbullying. To a lesser extent, teachers also experienced cyber bullying due to the use of E-Tech in schools and classrooms. In support, Borup (2016) reveals bullying and cheating as drawbacks to digital learning. The last setback was identified as teachers' lack of digital skills and pedagogies. In a similar study conducted in Capricorn District on Limpopo Project Schools, it was found that teachers lack digital literacies and preferred to use traditional pedagogies (Lekgothoane & Thaba-Nkadimene, 2019). It is most unfortunate and a disturbing situation to find teachers who still declare lack of digital skills in the 21st Century. Their declaration is a clear indication that they do not blame themselves, but blame the DBE for not providing teachers-development programmes that will equip them with the digital skills that are required for promotion and implementation of the e-Education Policy in all South African schools. Conversely, if teachers are trained but not supplied with necessary workplace tools, then the intended outcome cannot be achieved. This clarifies the significance of digital learning spaces that need to be introduced, along with the digital training of teachers.

CONCLUSION

The study responded to two primary research questions, namely, what are experiences and reflections of principals' and teachers' on the use of educational technology?" and "What do they think are benefits and challenges of such digital technologies?" The interpretivism research paradigm was used to inform the choice of a semi-structured interview and observation qualitative research designs as data collection tools. Four schools in the Mopani District were conveniently selected and, in each school, a principal and two teachers were purposively selected. A total of four principals and eight teachers were interviewed on a one-on-one basis. Research findings revealed that there was inadequate educational technological provisioning in Mopani District schools in the Limpopo Province, with subsequent minimal usage levels by principals and teachers. Secondly, it was revealed that principals and teachers who participated in the study believe that E-Tech can improve student learning, improve student engagement and improve learners' results. Lastly, setbacks revealed from this study include lack of focus (minimal teacher and learner interaction) because learners are distracted by social media. Learners and to lesser extent teachers, experience cyber bullying. Also, the teachers unfortunately still lack digital skills and pedagogies.

RECOMMENDATION

This study recommends that the Department of Basic Education should provide all public schools with E-Tech that is active, advanced and interactive, which will promote the establishment of the required digital space. Furthermore, the Department should provide principals and teachers with digital training and support of teachers who still lag behind. Large scale research should be conducted on the digital skill of teachers in rural schools and their pedagogical knowledge in order to establish the level of digital learning in schools and to establish the level of educational technologies provisioning and ICT infrastructure in these schools. This paper will be an eye opener to Mopani community with respect to the level of educational technology usage, ICT infrastructure, and the level of teachers' readiness to use such modern educational technologies.

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REFERENCES

Ahmadigol, J. (2016). New definition of Education technology. *Proceedings of 39th Annual Convention of the Association for Educational Communications and Technology* held in Las Vegas. pp.1-3.

Blignaut, A. S., Hinostroza, J. E., Els, C. J., & Brun, M. (2010). ICT in education policy and practice in developing countries: South Africa and Chile compared through SITES 2006. *Computers & Education*, *55* (4), 1552-1563.

Borup, J. (2016). Teacher perceptions of learner-learner engagement at a cyber high school. International Review of Research in Open and Distributed Learning, 17 (3), pp.231-250.

Chowdhury, M. F. (2014). Interpretivism in aiding our Understanding of the contemporary social world. In: Science Research. Open *Journal of Philosophy* 4, 432-438. http://www.Scirp.Org/Journal/Ojpp.

Department of Education (2004). *E-Education Policy*. Pretoria: Government Publishers.

Department of Basic Education (2016). *Provision of ICT in schools: department of Basic Education and Department of Telecommunication and Postal Service briefing*. https://pmg.org.za/committee-meeting/22096/

Department of Basic Education (2018). *Professional Development Framework for Digital Learning.* Pretoria: Government Publishers.

El-Hussein, O. & Cronje, C.J. (2010). Defining Mobile Learning in the Higher Education Landscape. *Journal of Educational Technology & Society, 13 (3)*, 12-21.

Gauteng Department of Education (2016). *GDEICT AND E-Education strategy and implementation progress.* https://pmg.org.za/committee-meeting/22096/.

Hannaway, D.A.M. (2017). *Teachers' and learners' experiences of technology-based teaching and learning in the foundation phase* (Doctoral dissertation, University of Pretoria).

Jakes, D. (2015(. *Digital Learning Spaces: A Multidimensional Approach. Part 4: Digital Learning space*.https://www.edtechteam.com/blog/2015/12/digital-learning-spaces/. Retrieved on 29 January 2020.

Januszewski, A & Molenda, M. (Eds.) (2008). *Educational technology. A definition with commentary technology:* New York. Lawrence Erlbaum Associates.

JICS e-Space Learning (2005). *Designing spaces for effective learning. A guide to 21st Century Learning Space Design.*

Lekgothoane, R.L., Thaba-Nkadimene, K.L. (2019). Assessing principals' and teachers' perceptions on the implementation of e-Education policy: a case study of four Limpopo project schools. *African Renaissance*, *16* (3), pp. 27-47.

Montrieux, H., Vanderlinde, R., Schellens, T., De Marez, L. (2015). Teaching and learning with mobile technology: A qualitative explorative study about the introduction of tablet devices in secondary education. *PloS one*, 10 (12).

Ndlovu, N.S. & Lawrence, D. (20120. *The quality of ICT use in South African classrooms, paper presented at a conference*, University of Cape Town.

NEMISA, 2020. *Digital Skill Summit. Research Colloquium. Postgraduate Symposium. Call for papers.*

Pholotho, T. and Mtsweni, J., (2016). Barriers to electronic access and delivery of educational information in resource constrained public schools: A case of Greater Tubatse Municipality. In *2016 IST-Africa Week Conference* (pp. 1-9). IEEE.

Ramorola, M.Z. (2010). *A study of effective technology integration into teaching and learning: A case study*. Med thesis, University of South Africa.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Savvidis, P. (2020). *Top 6 benefits of using technology in the classroom.* https://www.webanywhere.co.uk/blog/2016/02/top-6-benefits-technology-classroom/. Retrieved on 30 January 20202.

Spaull, N. (2012). 2 education systems. Presentation at UNISA. http://www.unisa.ac.za/cedu/news/wp-content/uploads/2012/07/Nic-Spaull-supporting-slides-for-us-in-article.pdf.

Thanh, N.C. & Thanh, T.T.L. (2015). The Interconnection between Interpretivist Paradigm and Qualitative Methods in Education. *American Journal of Educational Science*, 1 (2): 24-27. http://www.aiscience.org/journal/ajes.

UNESCO (2011). *Transforming education: The power of ICT policies.* https://unesdoc.unesco.org/ark:/48223/pf0000211842.

U.S. Department of Education (2017). *Reimagining the role of technology in education: 2017 National Education Technology Plan Update.* http://tech.ed.gov.

University Homework Help (2015). 15 *Disadvantages of technology in Education*. https://universityhomeworkhelp.com/15-disadvantages-of-technology-in-education/.

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NEEDS ASSESSMENT ON BASIC ICT LITERACY TRAINING FOR PERSONS WITH DISABILITIES: AN EASTERN CAPE CASE STUDY

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ABSTRACT

Aim/Purpose The purpose of this paper is to report on the results obtained from a workshop entitled "Assistive ICT technologies for persons with disabilities", held in the Eastern Cape (EC) province in 2019. The workshop was organized by the NEMISA EC eSkills CoLab as an introductory and showcase event to improve access to computer services for persons with disabilities, using readily available ICT tools. The use of the readily available ICT tools reduces the need to purchase assistive devices. The event was also an opportunity to understand the training needs and ICT infrastructure available at organizations that work with persons with disabilities in the EC province.

Background The EC eSkills CoLab based at the Walter Sisulu University (WSU) is mandated by NEMISA to deliver e-skills training around the EC province. We conducted this workshop in order to showcase accessibility of ICT tools that can be used by people with disabilities and also conduct a needs assessment that can be utilized to develop suitable ICT training programmes for persons with disabilities.

Methodology The assistive ICT technologies workshop for persons with disabilities was conducted in Mthatha, OR Tambo District municipality in the Eastern Cape. The 105 people in attendance were persons with disabilities and representatives of organizations that work with persons with disabilities. They were shown readily available accessibility tools available on the Windows 10 and Microsoft Office suite. At the end of the workshop, a survey was conducted to determine the e-skills training prospects for persons with disabilities. 75 people participated in this survey which consisted of a questionnaire with 24 questions.

Contribution This paper can be used by researchers and organizations offering e-skills training to ensure the inclusion of persons with disabilities. Persons with disabilities have different special needs that have to be considered, therefore, mainstream computer training programmes may not be suitable.

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Findings	Research findings show that the current e-skills courses cannot be used without incorporating accessibility tools when training persons with disabilities. Also, the majority of special schools in the Eastern Cape had poor or no computer facilities and as such alternative training venue may need to be arranged for future training programmes.
Recommendation for Researchers	Practitioners should use accessibility tools when training persons with disabilities.
Recommendation for Researchers	Researchers should develop e-skills courses which incorporate ICT accessibility tools. Different disability groups should be taken into consideration. For an example, accessibility tools used by visually impaired persons are different from those used by persons with physical impairments, each group is unique.
Impact on Society	The National Development Plan (NDP) states that every South African citizen must be e-skilled by 2030. Therefore, this paper describes how persons with disabilities can be included in e-skills training programmes.
Future Research	Further ICT programmes specifically designed for persons with disabilities.
Keywords	e-Skills, Disabilities, Eastern Cape, Accessibility Tools.

INTRODUCTION

The National Electronic Media Institute of South Africa (NEMISA) plays a role in providing solutions to South Africa's e-skills challenge. NEMISA's mission is to drive the national digital skills training agenda, enhancing competence for sustainable socio-economic development in South Africa. In order to achieve this, there is a need for multi-stakeholder partnerships between national, provincial and local organizations on e-skills interventions. NEMISA's presence in the Eastern Cape (EC) province is through an eSkills CoLab based at Walter Sisulu University (WSU). The EC eSkills CoLab, whose thematic area is ICT for Rural Development, offers a range of digital skills training programmes in the host province (NEMISA, 2017). The national mandate is that e-skills programmes should be inclusive of persons with disabilities as their population numbers are quite substantial in South Africa. Also, there is a need for persons with disabilities to contribute more to their own socio-economy and that of the country.

In 13 March 2019, the EC eSkills CoLab organized a workshop on assistive ICT technologies for persons with disabilities. EC Special Schools (i.e. schools that can better accommodate disability conditions), government departments, NGOs, Higher Education Institutions (HEIs) and any other organizations that work with persons with disabilities were invited. The workshop was facilitated by a company that focuses on digital technologies specifically for the special needs or persons with disabilities. The purpose of this workshop was two-fold; firstly, it was meant to introduce readily available, assistive ICT tools to persons with disabilities and organizations that work with them. It was a very interactive workshop; most participants indicated that the workshop content had given them valuable information on freely available assistive tools on Windows and the Microsoft Office package, e.g., screen magnifiers, text-to-speech applications and shortcuts. Secondly, the EC eSkills CoLab wanted to assess the current status of e-skills training programmes and initiatives for different disability groups in the EC Province. The participants were asked what type of ICT technologies and assistive devices they were using and what type of e-skills training programmes they are interested in. Their responses are discussed in later sections of this paper.

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LITERATURE REVIEW

Assistive devices or assistive aids are equipment that can be used by persons with disabilities to complete day-to-day activities, for learning and for work (Assistive Technology Devices, 2017). There are different types of assistive devices for people with different disabilities; some are considered "low tech" and inexpensive, while others are "high tech" and more expensive (Wu et al., 2002). Assistive devices are categorized according to their use. They include accessories, computers and electronic aids, household and cooking aids, educational aids, glasses and eye protection, mobility aids, reading aids, sports and hobby aids, as well as writing and printing aids (Nicolson et al., 2012). Examples of assistive devices include persons with visual impairments that can use products with braille markings (Duhaney & Duhaney, 2000). Hearing technologies for Deaf and Hard-of-Hearing (DHH) individuals include hearing aids, cochlear implants and classroom sound field amplification (Stumbo et al., 2009). People with physical disabilities may use mobility aids such as wheelchairs, walkers and prosthetic devices (Assistive Technology Devices, 2017). The focus of this paper is on freely available assistive Windows 10 and Microsoft Office (365/2016) suite technologies that can be used by persons from different disability groups. This reduces the need for them to purchase additional, expensive assistive devices for computer training and use.

Assistive computer devices are designed to convert general information into that which can be easily utilized by persons with special needs and for conversion of information that was created by people with special needs into a form that people with no disability can work with or into a form suitable for processing by a computer (Cercone & Naruedomkul, 2013). Research-based evidence of building assistive technologies, in particular, the user interaction with a computer based on fuzzy linguistic variables, is a subject of a number of publications. Huseyinov (2012) has published some research of building assistive technologies for the English and Thai languages. In the book, “Models of Processing Speech”, means of translation from a Thai spoken language to Thai sign language and algorithmic methods, means of reading mathematical formulas, algorithms of splitting sentences into simpler understandable formats and educational programs for persons with disabilities are considered.

People with physical disability are affected in many ways due to lack of movement around the environment they are in. In today’s world, almost everything can be automated, for example, kitchen hardware and automatic doors. The lives of people with physical disabilities can be made easy by making use of these assistive devices (Craig et al., 2005). In his publication Struijk (2006) developed a system that uses tongue control methods as they are practically manageable by people with severe physical disabilities. As there were systems already developed for eye movement, head movement and voice recognition, he thought coming up with tongue control movement might help due to the fact that it requires less concentration. Tests nonetheless proved that it was not the fastest system; multiple attempts to interface it with electrical contacts and pressure sensors showed no improvement to previous systems (Struijk, 2006). Researchers found that pressure sensors and electrical contacts could not function during eating and talking.

In his publication, Bengisu (2010) conducted a survey of 80 people who are visually impaired in Turkey. Participants were asked questions such as: “What are the products or technologies that you use to aid your daily life?, “What are the products or technologies that you wish to use but have not been able to?”, “What are your reasons of not using them?” The three most used assistive products in this survey were computer screen readers (46%), talking watches (26%), and screen readers for cellular phones (21%) (Bengisu, 2010). The results of the study

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also showed that cell phone with screen reading capability was the most desired assistive device among the people living with visual impairment. The reason people are currently not using them is their high cost, people cannot afford to buy them (Bengisu, 2010).

METHODOLOGY

As previously mentioned, the EC eSkills CoLab sent out a public invitation to different organizations that work with persons with disabilities within the province. The response to the invitation was overwhelming as 105 people attended the one-day workshop that was held in Mthatha, an area located in the OR Tambo District Municipality. The workshop morning session was used to define different types of disabilities and discuss a theoretical model which defines the severity of an impairment over a person's lifetime. Disabilities are a complex set of conditions whose nature needs to be understood in order to understand an individual's capabilities and needs in terms of the relevant ICT technology necessary for customizing their learning programmes. The facilitator then introduced different accessibility ICT tools usable by persons with disabilities by showcasing readily and freely available Windows and Microsoft Office technologies. Currently, Windows 10 and Microsoft Office have more than 40 accessibility tools. Examples of Windows accessibility tools include keyboard combinations, shortcut keys and adjustment of the mouse functionality (e.g. the ClickLock). More examples of specific visual, hearing, speech, physical and intellectual accessibility tools are shown in Table 1. The workshop was insightful for most of the participants as most were unaware of the existence of the freely available ICT technologies that can assist them. The participants were very engaging and inquisitive.

Table 1. Examples of Windows Accessibility Tools.

Accessibility Tool Type	Examples
Visual	Magnifier, color filter
Hearing	Closed caption, visual notifications
Speech	Office speak
Dexterity	Sticky keys, On Screen keyboard
Intellectual	Immersive Reader

The EC eSkills CoLab team then conducted a needs assessment survey to determine possible ICT training programmes that are based on freely available ICT technologies for persons with disabilities, with the input of the workshop participants. For example, the workshop participants were asked which organizations are interested in training programmes for persons with disabilities, how their organizations can be assisted in terms of training using assistive technology devices, what type of disabilities their organizations deal with currently and what ICT infrastructure they currently have. This needs assessment survey consisted of a questionnaire with 24 open and close ended questions, 75 responses were received. The next section discusses some of the results from the needs assessment survey.

DISCUSSION OF RESULTS

The EC eSkills CoLab received 75 responses to its ICT needs assessment survey that focused on understanding the status of ICT related infrastructure and training for persons with

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disabilities within the EC province. Some organizations were represented by more than one participant as such, 75 responses were received overall. The responses received were representative of five of the seven district municipalities in the EC, namely, Amathole, Alfred Nzo, Chris Hani, Joe Gqabi and OR Tambo district municipalities. The organizations represented by the respondents were also very diverse; the provincial and district government departments were Department of Education (DoE), Department of Social Development (DSD), Department of Rural Development and Agrarian Reform (DRDAR) and the Department of Public Service and Administration (DPSA). The Special Schools were Efata, Tembisa, Sive, Khanyisa, Awtose, Nolitha, Ikwezi Lokusa Rehabilitation, Nyandeni People with Disabilities and Albinism Society of South Africa. The HEIs were Walter Sisulu University (WSU), University of Fort Hare (UFH), King Sabata Dalindyebo TVET, Lovedale TVET and other private ICT facilities that host ICT training programmes. Some of these organizations do not specifically focus on e-skills for persons with disabilities. However, from time to time they receive learners with disabilities who they would like to cater for.

It was necessary to understand the prevalence of computers and computer skills amongst the survey respondents; 38 people had computers, 32 did not have computers and 5 did not respond to the question. In terms of computer skills, 42 participants responded that they could use a computer without any assistance, 32 participants either could not use a computer or required assistance to use it, only one person did not respond to the question. Also, 51 participants indicated that they had attended a computer course before, 21 had not and 3 participants did not respond to this question. The reason behind the high computer ownership and usage was a large presence of managers and educators who use computers purchased by their organizations in order for them to conduct their day-to-day work activities. However, the respondents had clearly attended the workshop in order to learn about assistive ICT tools for five types of disabilities that they dealt with at their institutions, that is, vision, hearing, intellectual and learning, physical and speech. The types of disabilities and corresponding number of respondents are shown in Figure 1.

During the workshop itself, it soon became very apparent to all participants that any ICT training programme needed to be tailored for each specific disability group. A practical example of this was that while the accessibility ICT tools were being showcased in the workshop, participants with visual impairments felt the overhead lights were too bright and needed to be switched off, while those with hearing impairments needed the overhead lights to be left on so that they could clearly see the sign language interpreter.

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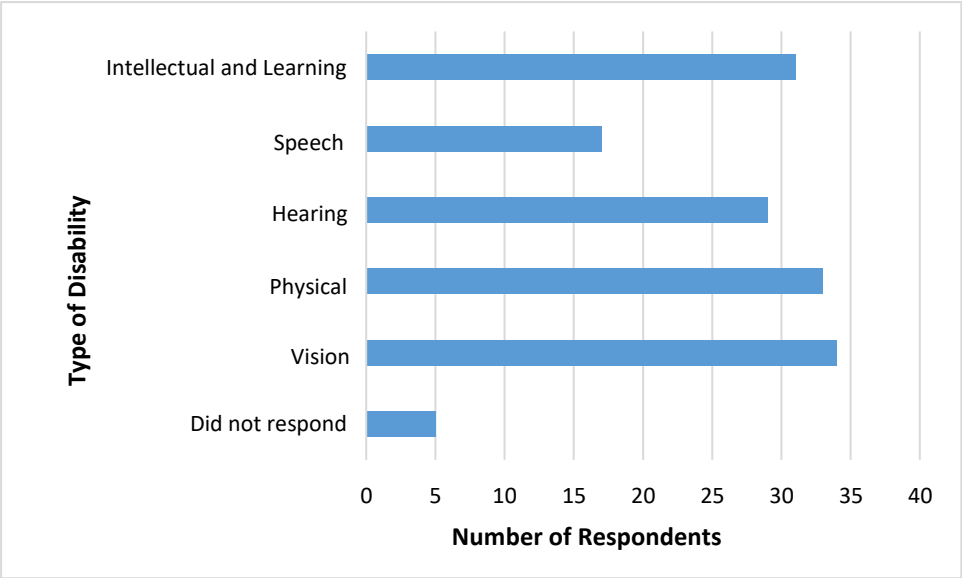

Figure 1: Nature of impairments that respondent's organizations focus on.

In 2011, Statistics South Africa published that the Eastern Cape had 472 106 or 9.6% prevalence of persons with disabilities (Statistics SA, 2011). The EC eSkills CoLab survey had requested the respondents to state the approximate number of persons with disabilities that they worked with at that point in time. As shown in Figure 2, the organizations represented collectively worked with approximately 7361 persons with speech impairment, 3803 persons with intellectual and learning disability, 1194 persons with hearing disability, 832 persons with visual disability and 222 persons with dexterity.

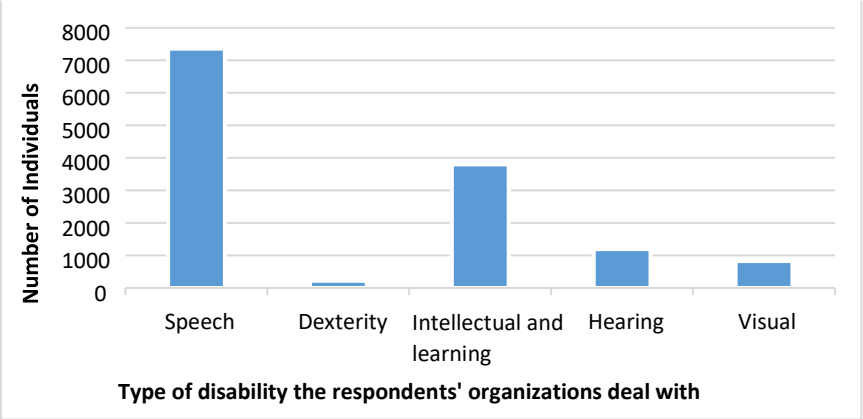

Figure 2: Overall number of persons with disabilities the respondents represented.

The current state of the ICT facilities of the different organizations was important to note. As shown in Figure 3, the EC eSkills CoLab survey confirmed that 33 respondents (44%) felt that the ICT facilities at their organizations were in poor condition. There were 25 respondents (33%) that felt that their ICT facilities were good, while only 8 respondents (10.7%) felt their ICT facilities were in excellent condition. The respondents with excellent computer facilities were mostly affiliated to HEIs and private computer training centers. Unfortunately, the majority of the respondents with poor computer facilities were from the Special Schools. This

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means that their ICT facilities will need to be upgraded first before any effective ICT training can occur.

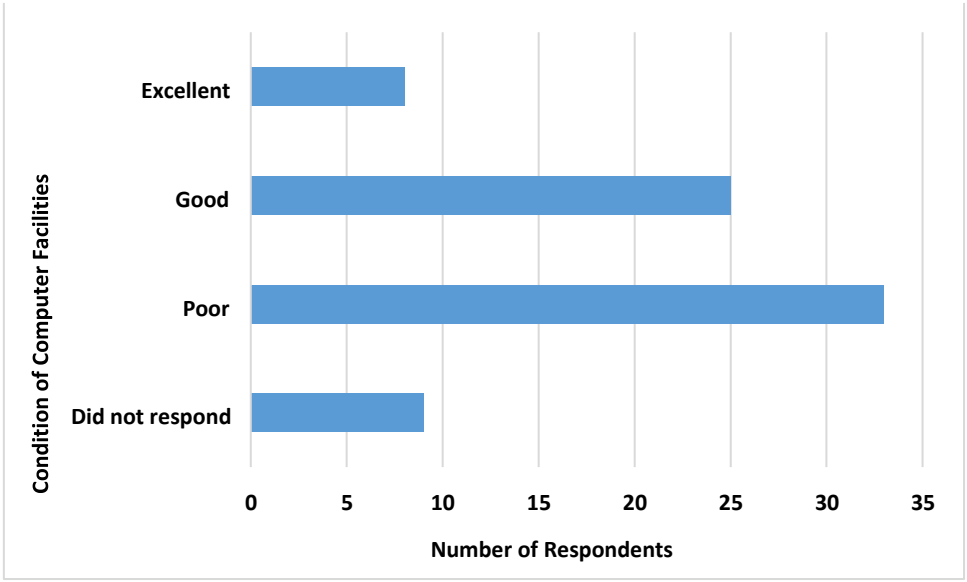

Figure 3: Conditions of Organizations Computer Facilities.

As shown in Figure 4, the respondents also stated additional challenges that they face at their organizations. While 44 respondents felt they needed assistive devices, other respondents felt that they needed more government support, computers, computer centers, training, counselling and awareness.

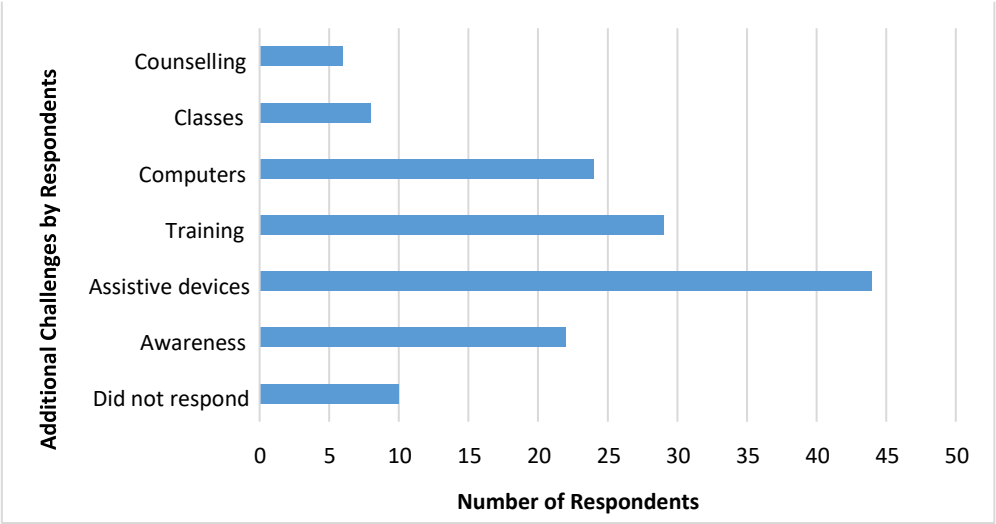

Figure 4: Additional challenges faced by organizations working with persons with disabilities.

The survey respondents were asked if their organizations used any assistive devices to support their learners. The majority (61%) said no, while 23% said yes as depicted in Figure 5. About 11% were not sure and they opted for the maybe option. Lastly, 5% did not respond to this question. The ICT assistive devices as noted by the respondents include braille terminals, printers for the visually impaired, yellow keyboards, Go Talk, ruby readers, victor

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readers, talking calculators and talking dictionaries. None of the respondents indicated that they currently use free Windows and Microsoft Office accessibility tools in their training programmes. All respondents were interested in e-skills training for persons with disabilities and this prompted the EC eSkills CoLab to arrange a pilot ICT accessibility tool training programme with Efata special school as discussed in the next section.

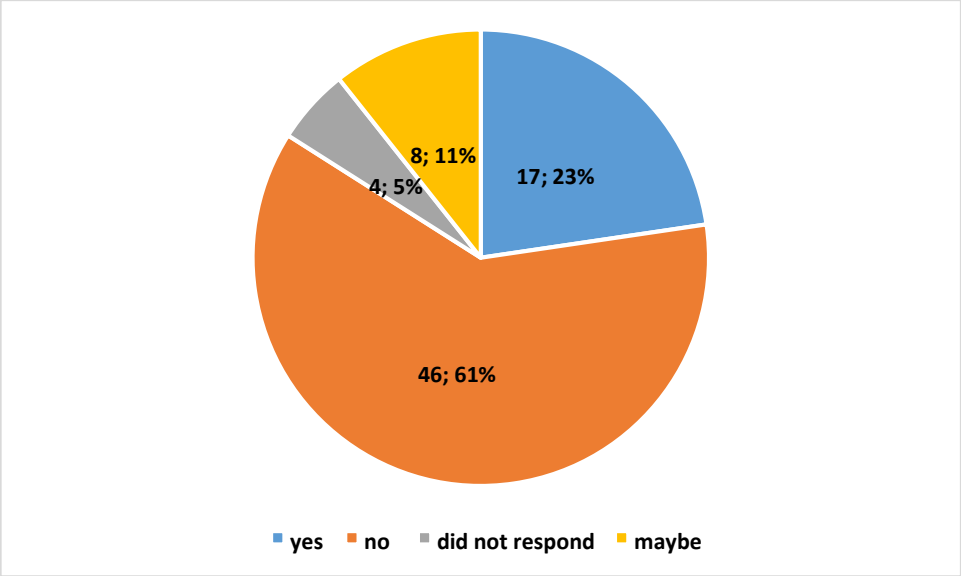

Figure 5: Are assistive devices used in your organization?

CONCLUSION AND RECOMMENDATIONS

Most participants of the assistive ICT technologies for persons with disabilities in the workshop were from government departments (especially DoE) and Special Schools around the Eastern Cape Province. The Special Schools cater for learners with special needs and they saw a lot of value in the workshop and therefore attended in large numbers. The Special School educators and caregivers were vocal about the shortage of ICT resources, i.e., infrastructure, internet and ICT educators, making it difficult to deliver any e-skills training programmes. This contributes to the extreme shortage of e-skills amongst persons with disabilities.

The EC eSkills CoLab conducted this workshop in order to collect information about the state of e-skills training for persons with disabilities in the Eastern Cape Province. Subsequently, a pilot basic ICT literacy training was organized with 29 educators and visually impaired learners from Efata School for the Blind and Deaf at a WSU computer facility which is in the vicinity of that Special School. The training participants from Efata were visually impaired and were a mix of moderate, severe and blind in terms of the extent of impairment. Their computer proficiencies were different, some learners and educators had prior experience at using computers and others had little to no computer knowledge. The 3-day training course introduced computer navigation, Microsoft Word, Presentation and the Internet using the keyboard, shortcut keys, the zoom, the magnifier and the Narrator on Windows 10 computers.

The needs assessment workshop was very helpful in terms of planning for the upcoming ICT accessibility tools training because the results of the survey conducted during this workshop were used by the facilitator in delivering the training to the Efata educators and learners during a pilot run.

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The EC eSkills CoLab recommends the roll-out of e-skills training programmes to persons with disabilities around the country. The facilitators should ensure that the training participants are grouped according to disabilities to ensure a smooth running of the e-skills training.

REFERENCES

Assistive Technology Devices, UN Accessibility Centre. (2017). Https://Www.Un.Org/Development/Desa/Disabilities/Wp-Content/Uploads/Sites/15/2019/03/AssistiveTechnology-Devices-2017_Eng.Pdf. Last Accessed November 06, 2019.

Bengisu, M. (2010). Assistive technologies for visually impaired individuals in Turkey. Assistive Technology®, 22 (3), pp. 163-171.

Craig, Y., Tran, P., McIsaac, P and Boord. P. (2005). The efficacy and benefits of environmental control systems for the severely disabled. Med. Sci.Monit. 11 (1), pp. RA32-RA39.

Duhaney, L. M. G., & Duhaney, D. C. (2000). Assistive Technology: Meeting the Needs of Learners with Disabilities. International Journal of Instructional Media, 27 (4), pp. 393-393.

Huseyinov, I.N. (2012). Fuzzy Linguistic Modelling Computer Interaction: Adaptation to Cognitive Styles using Multi Level Fuzzy Granulation Method. In: Speech, Image, and Language Processing for Human Computer Interaction: Multi-Modal Advancements, Tiwary, Uma Shanker, and Tanveer J. Siddiqui eds., IGI Global, 2012. 1-386. Web. 2, Oct. 2015. pp. 1481-1496.

National Electronic Media Institute of South Africa (NEMISA) Website (2019). http://www.nemisa.co.za Last Accessed February 03, 2020.

Nicolson, A., Moir, L., & Millsteed, J. (2012). Impact of Assistive Technology on Family Caregivers of Children with Physical Disabilities: A Systematic Review. Disability and Rehabilitation: Assistive Technology, 7 (5), pp. 345-349.

Cercone, N.J., Naruedomkul, K. (2013. Computational Approaches to Assistive Technologies for People with Dis-abilities. Cercone, IOS Press, Computers, pp. 276.

Statistics South Africa (2011). Prevalence of Disability in South Africa. Retrieved February 03, 2020 http://www.statssa.gov.za.

Stumbo, N. J., Martin, J. K., & Hedrick, B. N. (2009). Assistive Technology: Impact on Education, Employment, and Independence of Individuals with Physical Disabilities. Journal of Vocational Rehabilitation, 30 (2), pp. 99-110.

Struijk, L. N. A. (2006). An inductive tongue computer interface for control of computers and assistive devices. IEEE Transactions on biomedical Engineering, 53 (12), pp. 2594-2597.

Wu, T. F., Meng, L. F., Wang, H. P., Wu, W. T., & Li, T. Y. (2002). Computer Access Assessment for Persons with Physical Disabilities: A Guide to Assistive Technology Interventions. In International Conference on Computers for Handicapped Persons, pp. 204-211. Springer, Berlin, Heidelberg.

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THE STATE OF READINESS OF SOUTH AFRICAN YOUTHS FOR THE FOURTH INDUSTRIAL REVOLUTION IN MPOLA MISSION

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ABSTRACT

Aim/Purpose	The fundamental question this study intends to address is how ready South Africa is for the Fourth Industrial Revolution (4IR) in terms of digital literacy and e-skills.
Background	The sweeping changes brought about by 4IR may require a new set of digital and/or e-skills and fundamental adaptation of the society to match the needs and changes resulting from this new revolution. Like other countries, South Africa needs to prepare its citizens for 4IR. This study considers the case of the youth of Mpola Mission with a view to establish their state of readiness for 4IR.
Methodology	A quantitative cross-sectional survey research design was used to conduct the study. Structured questionnaires were distributed to the potential respondents selected using a systematic sampling technique.
Contribution	The descriptive nature of this study accounts for the nature of digital skills and e-skills possessed by youth in Mpola to lay the foundation for policy direction in relation to 4IR and digital skills within the context of Mpola Mission. Considering the limitations of this study, findings emanating from this study may be used as a base for further study.
Findings	The findings emanating from this study suggest that the majority of youths of Mpola Mission can operate a computer without assistance. In addition, it was established that the digital literacy capability of the youth is at the literacy level where they are able to conduct day-to-day operations using any computing device. In general, most of the questionnaire respondents have the capability to navigate websites of different types of content, and assess information available on the internet without taking such information at face value. The e-skills possessed by the respondents was found to be slightly above average, and thus suggesting that the youth of Mpola Mission are slightly ready for the fourth industrial revolution in terms of digital literacy and e-skills.
Recommendations for Practitioners	Researchers, policy makers, educators, trainers and practitioners will find the findings of this study useful when planning for youth upliftment in the information and technology environment and thus position the youth to play a meaningful role in the 4IR.
Recommendations for Researchers	Similar studies should be considered for areas other than a semi-urban areas to establish if similar patterns can be established as far as digital literacy and e-skills are concerned.
Impact on Society	The issues identified in terms of 4IR readiness among the youth of Mpola Mission suggest that South African youth are, to some extent, ready for 4IR in terms of digital skills. However, the capability to fully comprehend 4IR and its implications for South African human capital is limited.

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Future Research	Further studies may expand the scope beyond digital literacy and e-skills to include innovative skills. This may shed more light on the state of readiness for 4IR in South Africa, particularly the areas that appear marginalised.
Keywords	Fourth Industrial Revolution; Digital Skills, e-Skills, Human Capital, Youth, Young adults, South Africa

BACKGROUND

World economic growth continues to depend more and more on modern technology. One component of modern technology is information technology, which is characterised by constant change and ushering new ways and methods of doing things. The extent to which the economic activities and overall social fabric cope with the ever-changing technological environment remains to be seen (Xu, David & Hi Kim, 2018). According to Schwab (2016), the world is moving towards the convergence of physical, technological and biological spheres of life. This makes it hard or even impossible to untangle these spheres. Schwab (2016) has termed this convergence of various components of human existence the Fourth Industrial Revolution (4IR).

Various studies have been conducted on the subject of 4IR and the nature and type of skills possessed by population to meet the requirements of the 4IR. After conducting a study on the skills for the 21st century among Organisation for Economic Co-operation and Development (OECD) countries, Martin (2018) has established that the majority of the youth in some of these countries possess low skills, including digital skills. In addition, the risk associated with an ageing segment of the population among OECD countries that is more skilled than the youth was highlighted. Using a series of indicators to determine the state of readiness of member states of the European Union (EU) to embrace the 4IR, Kuruczleki, Pelle, Laczi and Fekete (2016) have found that the EU is generally well prepared to meet any challenges posed by 4IR.

While a new mood of 4IR optimism appears to be prevalent throughout society in OECD and EU countries, the picture in developing countries, particularly African countries, appears to be completely different. Before even considering the issue of 4IR, the African continent is, as noted by Guliwe (2019), still grappling with the Third Industrial Revolution (3IR). Thus, the context in which studies are undertaken on 4IR matters is very important. The aim of this study is therefore to investigate the state of readiness of South Africa for 4IR in the context of a semi-urban area. The context is especially important given that the South African society is divided in terms of social strata in relation to digital literacy and e-skills as well as overall access to internet and/or the requisite 4IR technological infrastructure.

PROBLEM STATEMENT

The current and ongoing technological development, which has been termed the Fourth Industrial Revolution (4IR), is in many ways considered to be distinct from the Third Industrial Revolution (3IR). While 3IR came with revolutionary advancements in the areas electronics and information technology that led to the automation of manual labour, the role of the human force remained relevant (Xu, David & Hi Kim, 2018). The current revolution, 4IR, sees the role of human force diminishing slowly in a significant way (Prisecaru, 2016). The advent of 4IR should not be equated to the total exclusion of the role of the human force but should rather, as asserted by Saviotti and Metcalfe (2018), be seen as being in a state of evolutionary change.

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New technological developments seem to be facilitating changes in all facets of life at rates previously not experienced. The push towards a knowledge economy means that routine work formally conducted by human beings becomes secondary as knowledge-intensive roles become the centre of attention. However, such narratives shall not be fixated on the notion that only manually and routine-oriented labour is affected by 4IR. Instead, professional roles such as those of lawyers, computer programmers and other professions are also at stake. This latter view is supported by Cortes, Jaimovich and Siu (2017), who observed a decline in employment both for manual and professional labour in the United States of America. A similar picture is emerging in other countries such as Ukraine. According to Nina and Oksana (2017), there has been a tremendous decrease on the demand for professionals, specialists and common jobs in Ukrainian industries. Saviotti and Metcalfe (2018) ascribe these evolutionary changes to those of biological changes proclaimed by Darwin and other sociological theorists. It can be concluded that 4IR is another normal development in the life of this earth that needs to be embraced.

While 4IR is viewed by many economists as having an effect on employment figures (Frey & Osborn, 2013; Menon, 2019), a much broader analysis that looks beyond the economic and social impact is required (Xu et al., 2018). The advancement in machine learning, natural language processing and the overall automated reasoning also raises ethical dilemma as far as 4IR is concerned. Chief among these concerns is the invasion of privacy, which might be affected by aspects of 4IR such as machine learning and thus have a huge impact on individuals and the overall quality of their lives. Machine learning and artificial intelligent have cultivated a discussion of their ethical implications as far back as early 1980s (Behar, 1993), and the debate is still ongoing.

Although it has become a reality, 4IR is not necessarily generic and the context in which it occurs or is implemented should be considered. For example, the rollout of ICT infrastructure to address the digital skills among African countries is expected to be totally different from how this would be carried out in other parts of the world. In addition, the levels of digital literacy and the requisite type of digital skills required in one country are generally completely different from those of another country in another part of the world.

4IR requires a new and unique set of digital and e-skills and fundamental adaptation of the society to match the needs and changes brought by this new revolution. Similar to other countries, South Africa is bound, in one way or another, to be affected (if not already affected) by 4IR. The fundamental question for which this study intended to address was how ready South Africa young adults is for the 4IR in terms of digital skills and digital literacy? The term ‘young adults’ and ‘youth’ will be used interchangeably.

LITERATURE REVIEW

Technological advancements are at the heart of the Fourth industrial revolution (Nambisan et al., 2017). In this section, the issues of 3IR is discussed briefly prior to undertaking a review of the 4IR and related issues. The review includes the challenges and/or implications of 4IR on the global economy and social life, with a particular emphasis being placed on the continent of Africa, the rest of the world and the youth.

THE THIRD INDUSTRIAL REVOLUTION

Industrial revolutions such as the 3IR, which preceded the 4IR, were driven by science and technology. For Rifkin (2012), the shift from one industrial revolution to the other means that the preceding industrial revolution diminishes, albeit little by little. The ushering in of 3IR meant

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that the second industrial revolution (2IR) had to wane out. Different authors pin the beginning of the 3IR to between 1950 and 1960s (Stearns, 2018; Schwab, 2016). Most notably, the 3IR saw the dominance of electronics and information technology in general, which was thereafter followed by the establishment of the Internet. 3IR brought changes that were never seen before. The state of the economies of the time shifted away from the amassing of natural resources and moved to acquisition of information technology, which was facilitated by discoveries of the Internet (Blinder, 2006). This change led to the so-called information economy, which was driven mainly by the Internet (van Dijk, 2006).

New developments in 3IR naturally required a new set of skills to drive the 3IR or information-driven economy (Karvonen, 2001). According to Liu and Grusky (2013), the 3IR was skills-driven as opposed to the previous industrial revolutions that were labour intensive. The new skills-driven requirement brought about by the 3IR was expected because whenever an economic structure changes by way of an industrial revolution, the impact is felt on the nature of skills needed and the extent of the role and demand of the labour force. New technological developments bring about new changes, and the society has no choice but new to adapt to these changes. A study by Liu and Grusky (2013) that was undertaken at the height of 3IR revealed that the ratio, in terms of the number of categories, of skilled and unskilled occupations was on the increase, with social and cognitive skills at the cornerstone of the skills needed for the 3IR economy.

THE FOURTH INDUSTRIAL REVOLUTION

Two schools of thoughts exists regarding the definition of 4IR. Whereas the first school of thought regards 4IR as being distinct from the 3IR (Schwab, 2016; Prisecaru, 2016; Antunes, Pinto & Henriques, 2018), the other school of thought regards 4IR as an extension of 3IR (Loi, 2015). The assertion by Loi (2015) is centred around job polarisation and the way in which all previous industrial revolutions have, in one way or the other, maintained job polarisation. For Hudgson (2016), 4IR involves facilitating the deskilling of the workforce whereby tasks that were entirely in the domain of humans are now allocated to machines. Similarly, Hudgson (2016), posits that as much as machines can perform functions and utilise skills that were previously allocated to humans, some skills and functions cannot be automated. Some of the skills that cannot be automated include analytical skills that are not based on mathematical logic and therefore require human intervention.

For purpose of this study, the school of thought that advocates for the distinction between 3IR and 4IR, has been adopted. Furthermore, it is asserted that a reassessment of current e-skills is necessary to meet the challenges posed by 4IR. It is against this background that an investigation on the state of readiness of South African youths to embrace and make use of opportunities provided by the 4IR was undertaken.

The economic shifts arising from technological advancement of the past industrial revolutions have not been as disruptive as 4IR. To this end, due consideration should be given to whether 4IR can actually be defined within the context of disruptive changes. Allahar (2017) considers 4IR as a disruptive innovation in which technologies change the status quo in the way in which one conducts business of the day. Any disruptions brought about by 4IR impacts on the economic activities and overall quality of lives of ordinary citizens, and these disruptions can be either be positive and/or negative.

There are different definitions of 4IR. In the European communities, 4IR is referred to as Industry 4.0. The latter term can be attributed to the fact that 4IR affects mainly the economic sphere of life, and European economy is industry driven (Antunes et al., 2018). Antunes et al. (2018, p. 92) identify the following components that feature in 4IR: “production digitisation,

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automation and automated data exchange." These concepts constitute some of the core features of 4IR.

The alterative term used for 4IR is Second Information Technology Revolution (Lee, Yun, Pyka, Won, Kodama, Schiuma, Park, Jeon, Park, Jung, Yan, Lee & Zhao, 2018). This, clearly indicates the different perspectives from different schools of thought of 4IR. For this perspective, the extension of 3IR is emphasised more, than 4IR being a distinct revolution. The Second Information Technology Revolution sees the role played by information technology in changing the overall nature of industries, economy and social life (Lee et al., 2018). Additional information technology capabilities like internet of things (IoT), machine learning, big data analysis and the like, which are associate with 4IR, are thus considered additional enhancement to the existing information technological architecture of society. Despite phonetic and different terms used for the new revolution and/or information technology capabilities, the common thread is the information technology and the effects it has on economies, industries, politics and social life.

The alterative term used for 4IR is Second Information Technology Revolution (Lee et al., 2018). This, clearly indicates the different perspectives from different schools of thought of 4IR. For this perspective, the extension of 3IR is emphasised more, than 4IR being a distinct revolution.

The cross-cutting feature of 4IR is the blurring line between real and virtual life and the ever-improving intelligence of computer machines such that they mimic the human intelligence and the reasoning process. As rightfully stated by Lee et al. (2018), if the first and second industrial revolutions transformed the physical sphere of economy and 3IR transformed the cyber sphere of economy, then 4IR integrated both spheres of economy and thus gave rise to a different revolution called 4IR. It is for this reason that 4IR is associated with artificial intelligence, robotics, internet of things (IoT), cloud computing, big data, cyber-physical systems, and simulation and modelling, etcetera, in addition to medical and physics related technologies and development (Antunes et al., 2018; Patel, 2019).

For the purpose of this study, 4IR is defined as the fusion of technology in the economic and social life, the blurring of differences between real and virtual reality brought by technological advancement for which information technology represents and sometimes supersedes human intelligence in areas of automated processing of information and work, automated reasoning, and the extent in which information technology enhances and changes society.

4IR IN THE AFRICAN CONTEXT

Africa provides a unique perspective with respect to the meaning and application of 4IR, and this uniqueness requires a different approach to 4IR. According to Guliwe (2019), the African continent is still in 3IR, and is yet to fully embrace it. If this argument is anything to go by, then one may struggle to understand as to how African countries may usher in 4IR while still in 3IR. Nevertheless, it is in the best interest of Africa to attend both 3IR and 4IR concurrently for the continent is to fully embrace the latest industrial revolution.

According to Wim (2017), African countries are experiencing the effect of the so-called automation of industrial processes, and the ripple effects are on job losses and the diminishing of routine work. This experience is not unique to Africa per se. Rather, it is an intrinsic character of 4IR. This revolution presents the opportunity for Africa to re-industrialise (Wim, 2017). However, such re-industrialisation should adjust to the realities of the present economic model namely, the digital economy. Internet access and digital skills are pre-requisites for both 3IR and 4IR, yet African countries are still lagging behind on the two (Guliwe, 2019). One

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should consider, though, that there are intervening factors that impede internet access and digital skills. A case in point, in South Africa, is the challenge of low income, lack of drivers for adoption of internet as part of digital economy and, the limited infrastructure, skills and capabilities to utilise internet and digital tools that are prominent in 4IR and the digital economy (van Greunen et al., 2016).

The nature and level of readiness in relation to Internet access, information technology infrastructure, 3IR and 4IR differs from one African country to the other. According to Cilliers (2018), sub-Saharan African countries are on a much higher scale in relation to Internet adoption, 4IR and economic trajectory than other parts of the African continent.

4IR IN THE REST OF THE WORLD

The implications of 4IR are somewhat similar across the world. The difference lies on the level of industrial development among countries. For example, in European, Australian and certain Asian countries, the focus is more on the development of smart industries in which 4IR technologies are applied in the production value-chain (Karabegovic, 2017). To this end, smart industries see a proliferation of industrial robots in various sectors of the economy, particularly the automotive and plastics sectors (Karabegovic, 2017). Since 4IR in the abovementioned regions is understood within the context of industries (Antunes, Pinto & Henriques, 2018).

While Europe, Asia and Australia see 4IR within the prism of industries, some countries in Asia see 4IR as an economic model built on innovation, digitisation and technology. According to Jones and Pimdee (2017), a variation of 4IR in Thailand is called Thailand 4.0, and the underpinning factor in Thailand 4.0 is the use of creativity and technology for the betterment of the Thai people. Interestingly, Thailand 4.0 is driven by government as opposed to commercial industries. Consequently, the objectives of 4IR programmes differ fundamentally between the above-mentioned regions and Thailand. Thus, Thailand sees Thailand 4.0 as a service delivery matter than being about industrialisation in general. A different picture is witnessed in other Asian countries. A case in point is that of developing countries. According to Islam, Jantan, Hashim, Chong, et al. (2018), the automation of production processes in key industries of Bangladesh is lagging behind since there is minimal support for technology from the government.

There has been a witnessed digital divide in 3IR between developed and developing countries; and also, between rich and poor individuals even within specific developing countries. This is confirmed by the absence of developing countries in the list of top manufacturing countries (Liao, Loures, Deschamps, Brezinski, et al., 2017). Interestingly, top manufacturing countries also top the list of countries that have fully embraced 4IR. (Liao et al., 2018).

Another aspect of 4IR on the world scale is the changing nature of knowledge and skills required. While the role of humans is expected to dwindle as the 4IR matures, it is undisputed that chief among other things needed is that an adaptation to the new revolution in terms of digital literacy and e-skills is required (Schwab, 2016).

REQUIRED DIGITAL LITERACY FOR 4IR

According to Soby (2016), the terms “digital literacy”, “digital competence” and “digital skills” are featuring in the literature, research projects and policy documents, and sometimes used interchangeably. Digital literacy centres around the ability to use digital tools and the Internet, and on the understanding of the digital information presented in whatever format (Lankshear, 2016). Furthermore, Lankshear (2016) has identified the following elements that constitute digital literacy: knowledge assembly, information content evaluation, Internet searching and

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navigation of hypermedia content. Furthermore, Staunton (2017) states that digital literacy is the capability to cope in the learning, working and social environment within the digital society.

One may make a logical connection between digital literacy and 4IR concepts such as big data analysis, Internet of things, artificial intelligence, cloud computing and machine learning which are, in one way or the other, associated with information, analysis of information, knowledge base and internet as the backbone of 4IR. Digital literacy required for the 4IR is grounded on the knowledge and the ability to use the internet and process digital information in the manner that provides meaningful insight from the available data (Jama, 2019).

REQUIRED E-SKILLS FOR 4IR

The emerging economic frontier is built on disruptive innovation, which takes place at a very fast pace (Temelkova, 2018). The preceding argument recognises creativity as the proponent of the new economic era within the context of the 4IR. Digital creativity goes hand in hand with digital innovation. According to Manda and Dhaou (2019), innovation as the driver of 4IR calls for the need to pay attention to research and development as the fundamental pillar of the 4IR with technology as the denominator. It can be said that such argument proposes a focus to go beyond digital skills and/or e-skills for 4IR and thus be mindful of research and development capability which are a permanent feature of any economy. Gray (2016) raises the same sentiments of soft skills such as creativity, complex problem solving and negotiation among the top 10 skills needed in the new era of 4IR.

While the preceding discussion is valid on the subject of soft skills, the focus of this study is on e-skills and/or digital skills needed in the 4IR. E-skills and digital skills are often used interchangeably (e-Skills Malta Foundation, 2019; Martin, 2018; van Greunen et al., 2016). The same approach is adopted in this study.

e-Skills and/or digital skills can be classified in terms of levels and/or categories. Bacon and Mackinnon (2016) identify the following levels of digital skills: basic digital skills, digital skills for general workforce and digital skills for Information and Communication Technology (ICT) profession. For the authors, the first level defines skills that every person requires for the current digital environment whereas digital skills for the workforce comprises the basic digital skills and also skills that are needed to use ICT applications needed to perform the work of staff members whether self-employed or employed in the labour market. On the other hand, digital skills for ICT profession comprises the skills needed to create and/or develop ICT products and services. van Deursen & van Dijk (2009) have maintained that digital skills entails operational, formal, information and strategic skills. Similarly, the e-Skills Malta Foundation (2019) have identified the following digital skills in relation to ICT: generic, specialist, complementary and foundational skills. The description of these skills is similar in many ways to the above-mentioned digital skills, except that foundational skills refer to digital literacy. In addition, complementary skills refer to skills that are associated with ICT, but not necessarily ICT skills. While the perspective differs among authors on what constitute digital skills, what is common across the spectrum is that digital skills are centred around ICT use and/or its application to individual, societal, political, academic, economic and social needs.

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METHODOLOGY

RESEARCH QUESTIONS

This study seeks to answer the following research questions.

Main Research Question

The main research question of this study study is:

What is the state of readiness of South African youth for the Fourth Industrial Revolution (4IR) in terms of e-skills and digital literacy in the Mpola Mission within the eThekwini Municipality?

Research Sub-questions

1. The main research question is broken down into a set of four research sub-questions, namely:
2. What are the e-skills and digital literacy criteria that are needed for the Fourth Industrial Revolution (4IR) for young adults?
3. What is the digital literacy levels of South African youth in Mpola Mission?
4. What e-skills do South African youth within Mpola Mission possess?
5. How ready are South African youth within the Mpola Mission for the Fourth Industrial Revolution in terms of e-skills and digital literacy?

RESEARCH DESIGN AND METHODS

This research undertook a quantitative cross-sectional survey research design in which the study was expected to paint a picture of the state of readiness for the Fourth Industrial Revolution among young adults in the Mpola Mission. A structured questionnaire was designed and thereafter piloted with three individuals before being hand-distributed to potential respondents in the Mpola Mission who were selected using systematic sampling. The collected data form the questionnaire was captured using a spreadsheet (MS Excel 2016). Thereafter, the data was imported into a statistical package (SPSS Version 24), cleaned and analysed. The cleaning involved removing records that had a lot of missing values and some other criteria such as instances where the same Likert scale option was selected throughout the entire questionnaire. The analysis was focused on descriptive statistics such as mean and frequency values.

ETHICAL CONSIDERATIONS

Ethical clearance was granted by the University of South Africa (UNISA) in accordance with the University Policy on Research Ethics. For this study, the respondents participated in this study willingly and were informed of their right to withdraw their participation in the study at any time they wished to do so. In addition, a consent form was signed by each participant confirming voluntary participation in the study and acknowledgement that their rights were explained in the introduction section of the questionnaire.

STUDY CONTEXT

Mpola Mission (Ward 59500015) is a semi-urban area in the eThekwini Municipality of the Kwazulu-Natal Province of South Africa. The population of the Mpola Mission is estimated at 30 000 (Media Monitoring Group, 2016; eThekwini Municipality, 2018; Municipal Demarcation Board, 2016). At the time the study was undertaken, the majority of the population of the Mpola Mission was at least 18 years with a median age of 25 years (Media Monitoring Group, 2016).

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The population that is below 18 and above 65 years is estimated at 32.1% and 2.3%, respectively (Media Monitoring Group, 2016). This study was aimed at young adults consisting of individuals between the ages of 18 and 35 years, a category of the population which in South Africa is defined as youth (National Youth Commission 2000, 1997).

RESULTS

About 300 individuals were approached to participate in the survey. Of these, 125 completed the questionnaire. After the data cleaning process, data analysis was conducted on 109 usable questionnaires. As already stated, data analysis was performed using SPSS Version 24.

PROFILE OF THE RESPONDENTS

The gender distribution of the 109 respondents was 54.1% (59 out of 109) female and 45.9% (50 out of 109) were male. Despite 66% of the respondents having obtained at least a matric qualification (i.e. passed high school), a substantial majority (56.2%) of the respondents were unemployed. About 30.5% of the respondents were employed (full-time and part-time) and a mere 13.3% of the respondents were self-employed.

ACCESS TO COMPUTING DEVICES

Access to various computing devices is an important element of digital literacy (Jama, 2019). The data collected revealed that 85.3% (93 out of 109) of the respondents have access to a smartphone and 41.2% have access to a laptop. Personal computers were the least accessed at 21.6%. What is notable though is that both smartphones and laptop are portable computing devices compared to personal computers. These results could possibly be attributed to the portability level of a device, save for the tablet which is the third accessible device, at 33.3%, after the laptop even though the tablet is more portable. Besides portability, personal computers are often associated with workplace, and the data shows that the majority of participants, 56.2%, are unemployed compared to employed ones at 43.8%. However, no correlation was tested between employment status and access to various computing devices.

USE OF VARIOUS INTERNET CONNECTION TYPES

The usage of WiFi and Mobile Hotspot by the respondents to access the Internet was evenly distributed at 56.7% and 55.8%, respectively. In contrast to other respondents that use Local Area Network (LAN) (31.7%) and other Internet connection types (18.3%), it is quite evident that the majority of the respondents (average 56.3%) use wireless connection to access the Internet.

INTERNET SEARCHING AND INFORMATION ASSESSMENT

For purposes of this research study, factors governing Internet searching and information assessment was divided into three categories, namely: the ability to conduct internet searches; the ability to conduct information assessment; and knowledge of fundamental internet resources. The items on the questionnaire for all the above-mentioned categories were assessed by the respondents using a Likert scale of 1(Strongly disagree) to 5(Strongly agree). These categories are discussed individually and in more detail in the following sub-sections.

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Ability to Conduct Internet Searches

The ability to conduct an Internet search consists of 7 items on the questionnaire (see Annexure A). The mean of the aggregated items scores was 2.9; this score is slightly lower than the score of 3 representing a Neutral response on the Likert scale that was used in this research study. It can therefore be concluded that the ability of the respondents to conduct Internet searches is slightly below average.

Ability to Conduct Information Assessment

As shown in Annexure A, the part of the questionnaire relating to the ability to assess the information found on the internet for consumption and/or use consists of 5 items. The mean of the aggregated items scores was 3.0, which corresponds to the Neutral response. The conclusion, therefore, is that the respondents had average ability to assess the information found on the internet before consumption and/or use.

Knowledge of Fundamental Internet Resources

The part of the questionnaire relating to the category of knowledge of fundamental Internet resources consists of 3 items. The mean of the aggregated items score of 3.6 is well above the Neutral response of 3, which suggests that the respondents have an above average understanding and/or use of internet resources. Put differently, the respondents slightly agree that they have the knowledge of fundamental internet resources.

NAVIGATION OF WEBSITES WITH VARIOUS COMPONENTS

The ability to navigate websites with various components consisting mainly of a combination of one or more components (i.e., text, images and videos) was determined using 5 items in the questionnaire. The mean of the aggregated items scores was 3.1, which is only slightly above the Neutral response of 3. This indicates that the respondents had an average ability to navigate websites containing a combination of text, images and/or video.

ABILITY TO USE A COMPUTER WITH NO ASSISTANCE

Of the 109 questionnaires received, 4 respondents did not indicate whether they have the ability to use a computer without assistance. However, a substantial majority of the remaining respondents (68.6%; 72 out of the 105) indicated an ability to use a computer with no assistance. Therefore, on average the respondents can use a computer without any assistance.

KNOWLEDGE OF VARIOUS COMPUTER TECHNICAL OPERATIONS

The ability to perform various computer technical operations was measured using the 12 items on the questionnaire. The mean of the aggregated items scores was 2.1, which is slightly above the score 2 that indicates the “Disagree” response. It can therefore be concluded that the respondents are not sufficiently skilled to perform various computer-related technical operations.

POSSESSION OF E-SKILLS

A total of 11 items were used to establish the extent of the e-skills possessed by the respondents. The mean aggregated score of 3.3 that was obtained for the items is slightly

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above the score of 3 representing the Neutral response on the Linkert scale adopted for this research study. To this end, the levels of e-skills of the respondents is slightly above average.

KNOWLEDGE OF 4IR CONCEPTS

Respondents were requested to indicate how well they knew seven 4IR-related concepts, namely fourth industrial revolution, internet of things, big data, cloud computing, artificial intelligence, robotics and blockchain. On a scale of 1 (No knowledge) to 5(Advanced knowledge), the mean score of the aggregated items was 2.0, which corresponds to a "Basic Knowledge" level of response on the scale used. The obtained score suggests that the respondents have basic knowledge of 4IR concepts.

USE OF MULTIPLE SOCIAL MEDIA PLATFORMS

The use of social media platforms seemed to be generally very popular among the respondents. Using a three point scale of 0 (Never), 1 (Occasionally) and 2 (Always), respondents were asked to indicate their lever of use of 10 social media platforms, namely: WhatsApp; Facebook; Instagram; LinkedIn; Pinterest; SnapChat; Twitter; Viber; WeChat; and YouTube.

WhatsApp was found to be the most popular social media platform; all respondent indicated having used this platform. Furthermore, the respondents indicated that they "Always" use WhatsApp (88%) and Facebook (72.2%). On the other hand, the large majority of respondents indicated that they "Never" use Viber (95.4%), WeChat (73.1%), Pinterest (70.1%) or LinkedIn (69.4%). Interestingly, a substantial majority of respondents indicated that they "Occasionally" use Twitter (73.1%) and YouTube (64.8%). Based on the results obtained for this part of the research study, it can be concluded that the respondents generally use social media platforms as part of their daily lives.

DISCUSSION AND CONCLUSION

CRITERIA FOR E-SKILLS AND DIGITAL LITERACY NEEDED FOR 4IR

This subsection seeks to answer the first research sub-question:

1. What are the e-skills and digital literacy criteria that are needed for the Fourth Industrial Revolution (4IR) for young adults?

The literature review presented in this paper established various criteria in relation to digital literacy that one would need for 4IR. It was established that the terms digital literacy, digital competence, e-skills and digital skills can be used interchangeably (Soby, 2016; van Greunen et al., 2016). Among the required criteria are digital competence, digital skills and, the overall capability to conduct internet search, operate a computing device and understand the importance and implication of establishing the credibility of information found on the internet.

It should be borne in mind that digital literacy goes beyond the ability to operate a computing device. According to Lankshear (2016), digital literacy entails the ability to effectively utilise digital tools and internet including the ability to assess the quality and value of the digital information. The following elements have been considered by Lankshear (2016) as criteria for digital literacy: knowledge assembly, information content evaluation, internet searching and navigation of hypermedia content.

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DIGITAL LITERACY LEVEL AMONG YOUNG SOUTH AFRICAN YOUTH IN MPOLA MISSION

This subsection seeks to answer the second sub-question:

2. What is the digital literacy level of South African youth in Mpola Mission?

This study was focused on young South Africans adults (Youth) in Mpola Mission. The measure of digital literacy levels differs semantically among different authors but generally have common themes. According to Chetty et al. (2018), there are three tiers of digital skill levels, namely: literacy; fluency; and mastery. Similarly, the OECD (2016) has identified the following digital literacy levels: ICT generic skills, ICT specialist skills and complementary skills. Both generic skills and literacy level entail basic skills needed for conducting day-to-day operations using a computing device. In addition, specialist skills and fluency level refer to technical skills needed for understanding and operating a computer beyond the generic level. Mastery (advanced) skills constitutes the highest level of digital literacy.

In this research study, it was established that respondents possess the ability to use a computer without assistance and that they mainly use WiFi and mobile hotspot for internet connection. In addition, respondents were found to possess an average ability to assess the credibility and reliability of the information that they find on the Internet. In addition, it was found that the youth of Mpola Mission are generally able to understand and use various internet resources. Furthermore, respondents were found to possess the ability to navigate websites containing a variety of digital contents including images, text and videos. However, respondents experienced challenges with conducting Internet searches and performing computer technical operations. It can, therefore, be concluded that the respondents are at the literacy or ICT generic skills level in relation to digital literacy. These findings corroborate results obtained by Jones and Pimdee (2017), who found that similar levels of digital skills in Thailand, a developing country like South Africa.

DIGITAL SKILLS/E-SKILLS POSSESSED BY YOUNG ADULTS IN MPOLA MISSION

This sub-section seeks to answer the third research sub-question, which as follows:

3. What e-skills do South African youth within Mpola Mission possess?

This study established that the e-skills possessed by the youth of the Mpola Mission are slightly above average. These e-skills were measured using the following criteria (the e-Skills Malta Foundation, 2019):

- Understanding of financial risks associated with using internet;
- Using internet for learning and development;
- Ethical use of social media in relation to posting harmful contents and /or hiding author identity;
- Using internet to exchange ideas with others;
- Appreciation of risks associated with social media use;
- Not trusting information from internet at first value;
- Use of internet for information search; and
- Information/document backup.

It was found that respondents use computing devices, especially smart phones, for making and receiving calls. Furthermore, daily and regular use of social media platforms, especially WhatsApp, Facebook and Twitter, by the respondents was established.

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READINESS OF YOUNG ADULT IN MPOLA MISSION FOR 4IR

This subsection seeks to answer the fourth research sub-question, which is as follows:

4. How ready are South African youth within Mpola Mission for the Fourth Industrial Revolution in terms of e-skills and digital literacy?

The researchers could not find any well-articulated criteria for measuring readiness for the fourth industrial revolution among individuals in a specific country, community or society at large. Nevertheless, Kuruczleki et al. (2016) opined that 4IR is based on a mixture of knowledge- and digital-based society. Chief among new developments related to 4IR are internet of things, machine learning, artificial intelligent and big data analysis (Antunes et al., 2018; Patel, 2019).

This study has established that the understanding and level of knowledge of 4IR concepts among respondents is at the basic level. This suggests that respondents do not know much about 4IR concepts and technology. However, the possession of e-skills was found to be slightly above average, and participants were found to be slightly ready for the Fourth Industrial Revolution in terms of digital literacy and e-skills.

RECOMMENDATIONS

This study was limited to the youth of Mpola Mission of between the ages of 18 and 35 years. Mpola Mission is a semi-urban area in eThekwini region. The profile of the populations in rural and urban areas may be fundamentally different from a typical semi-urban area like Mpola Mission. To this end, it is recommended that a similar study be considered for areas other than a semi-urban area to establish if similar patterns can be established with respect to digital literacy and e-skills. In addition, the scope of the study can be expanded beyond digital literacy and e-skills to include innovative skills. Such an approach may contribute towards painting a better picture on the state of readiness for the 4IR in South Africa in general, particularly in marginalised areas resembling by the Mpola Mission.

The findings of this study may be of use to researchers, policy makers, educators, trainers and practitioners in terms of planning for youth upliftment in the information and technology environments so that the youth can begin to play and make a meaningful contribution in the 4IR. Therefore, findings of this study can be used as a baseline for future for youth development initiatives in the Mpola Mission.

CONCLUSION

This study was focused on digital literacy and e-skills among the youth (18 and 35 years) of the Mpola Mission area. The results indicate that the respondents possess average levels of digital literacy and just above average levels of e-skills. It is on this basis that a conclusion was reached that the youth of Mpola Mission, and by extension of South Africa, are slightly ready for 4IR.

REFERENCES

Allahar, H. (2017). Academic Publishing, Internet Technology, and Disruptive Innovation. Technology Innovation Management Review, 7(11), pp. 47-56.

Antunes, J.G., Pinto, A., Reis, P. & Henriques, C. (2018). Industry 4.0: A challenge of Competition. Millenium, 2(6), pp. 89-97.

Bacon, L & Mackinnon, L. (2016). Lifelong Digital Skills Development, Current Picture and Future Challanges, s.l.: UK Government Office for Science.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Behar, J. (1993). Computer Ethics: Moral Philosophy or Propaganda. Computer in Human Services, 9(3-4), pp. 441-453.

Blinder, A. (2006). Offshoring: The Next Industrial Revolution?. Foreign Affairs, 85(2), pp. 113-128.

Chetty, K., Aneja, U., Mishra, V., Gcora, N., & Josie, J. (2018). Bridging the digital divide in the G20: skills for the new age. Economics: The Open-Access, Open-Assessment E-Journal, 12(1), pp. 1-20.

Cilliers, J. (2018). Made in Africa: Manufacturing and the Fourth Industrial Revolution, Pretoria: Institute for Security Studies.

Cortes, G.M., Jaimovich, N., & Siu, H.E. (2017). Disappearing Routine Jobs: Who, How and Why?. Journal of Monetary Economics, 91(1), pp. 69-87.

eSkills Malta Foundation, (2019). National eSkills Strategy 2019-2021. [Online] Available at: https://eskills.org.mt/en/nationaleskillsstrategy/Documents/National_eSkills_strategy.pdf [Accessed 17 July 2019].

Frey, C.B., & Osborne, M.A. (2013). The Future of Employment: How Susceptible Are Jobs to Computerisation?, s.l.: September 17, 2013.

Gray, A. (2016). The 10 skills you need to thrive in the Fourth Industrial Revolution. [Online] Available at: https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/
[Accessed 17 July 2019].

Guliwe, T. (2019). The Fourth Industrial Revolution and the Future of the Labour Intensive Sectors in the Developing Countries: The Hailstorm in a Cup of Tea. Africagrowth Agenda, 16(1), pp. 14-18.

Hudgson, G. (2016). The Future of Work in the Twenty-First Century. Journal of Economic Issues, 50(1), pp. 197-216.

Islam, A., Jantan, A.H., Hashim, H.B., Chong, C.W., Abdullah, M.M., Ramhan, A., & Hamid, A.A (2018). Fourth Industrial Revolution in Developing Countries: A Case on Bangladesh. Journal of Management Information and Decision Sciences, 21(1).

Jama, N. (2019). Digital Literacy in the Fourth Industrial Revolution [Interview] (3 July 2019).

Jones, C., & Pimdee, P. (2017). Innovative ideas: Thailand 4.0 and the fourth industrial revolution. Asian International Journal of Social Sciences, 17(1), pp. 4-35.

Karabegovic, I. (2017). Comparative analysis of automation of production process with industrial robots in Asia/Australia and Europe. International Journal of Human Capital in Urban Management, 2(1), pp. 29-38.

Karvonen, E. (2001). Informational Societies: Understanding the Third Industrial RevolutionEdited by Erkki Karvonen. Tampere: Tampere University Press.

Kuruczleki, E., Pelle, A., Laczi, R. & Fekete, B. (2016). The Readiness of the European Union to Embrace the Fourth Industrial Revolution. Management, 11(4), pp. 327-347.

Lankshear, C., & Knobel, M. (2016). Digital Literacy and Digital Literacies: Policy, Pedagogy and Research Considerations for Education. Nordic Journal of Digital Literacy, pp. 8-20.

Lee, M., Yun, J.J., Pyka, A., Won, D., Kodama, F., Schiuma, G., Park, H., Jeon, J., Park, K., Jung, K., Yan, M., Lee, S., & Zhao, X. (2018). How to Respond to the Fourth Industrial Revolution or the Second Information Technology Revolution?: Dynamic New

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Combinations Between Technology, Market and Society Through Open Innovation. Journal of Open Innovation, 4(21), pp. 1-24.

Liao, Y., Loures, E.R., Deschamps, F., Brezinski, G., & Venancio, A. (2017). The impact of the fourth industrial revolution: a cross-country/region comparison. Production, Volume 28.

Liu, Y., & Grusky, D.B. (2013). The Payoff to Skill in theThird Industrial Revolution. American Journal of Sociology, 118(5), pp. 1330-1374.

Loi, M. (2015). Technological Unemployment and Human Disenhancement. Ethics Information Technology, Volume 17, pp. 201-210.

Martin, J. (2018). Skills for the 21st Century: Findings and Policy Lessons from the OECD Survey of Adult Skills, s.l.: Organisation for Economic Co-operation and Development.

Manda, M.I., & Dhaou, S.B. (2019). Responding to the Challenges and Opportunities in the 4th Industrial Revolution in Developing Countries. Melborne, 12th International Conference on Theory and Practice of Electronic Governance.

Menon, J. (2019). Why the Fourth Industrial Revolution Could Spell More Jobs - Not Fewer. [Online] Available at: https://www.weforum.org/agenda/2019/09/fourth-industrial-revolution-jobs/ [Accessed 12 January 2020].

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital Innovation Management: Reinventing Innovation Management Research in Digital World. MIS Quarterly, 41(1), pp. 223-238.

National Youth Commission (1997). Youth Policy 2000. National Youth Policy. National Youth Commission, Pretoria.

Nina, C., & Oksana, P. (2017). The 4th Industrial Revolution and Innovative Labor: Trends, Challenges and Forecasts. Zielona Gora, pp. 142-154.

Patel, A. (2019). HR Must Prepare for the 4IR. HR Future, January, pp. 8-9.

Prisecaru, P. (2016). Challenges of the Fourth Industrial Revolution. Knowledge Horizons - Economics, 8(1), pp. 57-62.

Saviotti, P.P., & Metcalfe, J.S. (2018). Evolutionary Theories of Economic and Technological Changes: Present Status and Future Prospects. Pennsylvania: Routledge.

Schwab, K. (2016). The Fourth Industrial Revolution. Cologny: World Economic Forum.

Soby, M. (2016). Digital Competence: A Password to a New Interdisciplinary Field. Nordic Journal of Digital Literacy, pp. 4-7.

Staunton, T. (2017). Education and the digital revolution. In: J. Marshall, ed. Contemporary Debates in Education Studies. London: Routledge, pp. 171-181.

Stearns, P. (2018). Industrial Revolution in the World History. 4th ed. NY: Routledge.

Temelkova, M. (2018). Skills for Digital Leadership: Prerequisite for Developing High-Tech Economy. International Journal of Information Theories and Applications, 25(4), pp. 343-363.

van Deursen, A.J.A.M., & van Dijk, J.A.G.M. (2009). Improving Digital Skills for the Use of Online Public Information and Services. Government Information Quarterly, 26(2), pp. 333-340.

van Dijk, J. (2006). The Network Society: Social Aspects of New Media. 2nd ed. London: Sage.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

van Greunen, D., Venter, I., Craffert, L., Veldsman, A., Candi, M & Sigurdarson, H.T. (2016). Diagnosis of the Digital Landscape in South Africa: Skills, Infrastructure and Available Technologies. [Online] Available at: https://www.commongoodfirst.com/wp-content/uploads/2018/02/WP2_full.pdf [Accessed 17 July 2019].

Wim, N. (2017). Entrepreneurship, Education and the Fourth Industrial. Bonn: Institute of Labor Economics.

Xu, M., David, J.M., & Kim, S.H. (2018). The Fourth Industrial Revolution: Opportunities and Challenges. International Journal of Financial Research, 9(2), pp. 90-95.

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ABSTRACTS AND SHORT PAPERS

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SECURITY AND PRIVACY CHALLENGES IN THE INTERNET OF THINGS DEVICES

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ABSTRACT

Aim/Purpose	In this paper, some of the security challenges in IoT devices is explored. The deployed mitigation schemes and ways in which they can be improved are also studied.
Background	Although IoT serves as a good remedy for an enhanced standard of living for communities and better interaction, contribution and collaboration with the increasing number of devices, IoT services are becoming more vulnerable to security threats. Therefore, improved security measures need to be investigated and deployed to handle the large sets of data utilized by IoT devices.
Methodology	This paper is a conceptual paper. Through a review of the literature, we evaluated the state of the art security mechanisms implemented and explored their effectiveness
Contribution	The paper will contribute to the identification of the security challenges associated with IoT devices and identify the deployed mitigation schemes and ways in which they can be improved. In addition, the paper will contribute to the existing body of knowledge on IoT and thus create an awareness of the security implications of IoT devices.
Findings	Thorough a review of the literature, a lack of awareness of the security implications of some of the IoT devices used by individuals has been highlighted. A need exists for individuals to be made aware of all risks associated with the IoT devices being used with a view to enable them to better protect themselves against cyber-attacks.
Future Research	Future research will explore more defence mechanisms and design a framework that can be used to bring awareness of risks involved to the IoT device users
Keywords	Defence Mechanism, IoT, IoT Devices, Security

INTRODUCTION

The great demand for efficient broadband connectivity has led to the realization and deployment of the fifth-generation (5G) cellular networks. More internet of things (IoT) devices are being deployed for efficient resource utilization, minimization of human effort and time-saving. IoT is revolutionary in that users, objects and computing systems have the ability to cooperate and communicate (Granjal, 2015). The phrase Internet of things (IoT) was first coined in 1999. IoT has SINCE grown tremendously (Roman, Zhou & Lopez, 2019; Terkawi et al. 2018; Weber, 2010). IoT is defined as the interconnection amongst internet-enabled objects or devices and humans to achieve a specific goal, allowing these objects to exchange and generate data (Jing et al., 2014). It is estimated that in the near future, connectivity of IoT devices will be more than the connectivity of people. Although IoT devices have many benefits, it still imposes major security risks (Jara, 2014). For instance, smart devices such as television

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which transmit data and allow online purchases impose some great security risks, sensitive bank information, passwords and personal data can facilitate financial and identity theft (Roukounaki et al., 2019). These security vulnerabilities can be targeted at communicating channels, data aggregation platforms and data centres. IoT services collect sensitive personal data that needs to be secured and protected (Chung, Jeongyeo & Youngsung, 2016). In this paper, some of the security challenges associated with IoT devices are explored. In addition, the deployed mitigation schemes and ways in which they can be improved are investigated.

LITERATURE REVIEW

Smart objects are increasing at an alarming rate to enhance the standard of living humans. Examples of smart devices include watches that collect sensitive data, smart TV, microwave, fridge, phones and some wearable devices (Sharaf-Dabbagh & Saad, 2017). These devices constantly collect data sometimes without the user being aware. According to Trusit & Venkatesan (2018), some IoT devices collect data to improve the quality of life for the individuals. Data such as health information, google searches, financial information are collected by these IoT devices. Moreover, IoT devices can share data from different streams. This interaction with other devices introduces a significant set of security challenges. Some IoT services which include banking applications deployed security measures and policies to ensure the security and privacy of its users. Nonetheless other IoT devices like the wristwatches and garage openers have no policies governing the privacy of its users. Most IoT devices make use of single password-based authentication mechanisms which are vulnerable to side-channel and dictionary attacks.

Hittu & Mayank (2019) have proposed a multi-key based mutual authentication mechanism to enhance the security of IoT devices. Their mechanism used secure vault to share sensitive information between the IoT server and the IoT devices. Nonetheless, should attackers be able to encrypt the communication between the server and the IoT device, the security implication of their proposed scheme will be compromised. Seungyong & Jeongnyeo (2017) have proposed a secure IoT system that does not allow attackers to infiltrate the network through the IoT devices known as the REST API. Their proposed model also exposed malicious devices that attempted to connect to applications in their cloud. Their model used middleware to expose device data through REST and act as an interface for the user to interact with sensor data. Their proposed scheme was shown to have many advantages because malicious users were unable to infiltrate the network to perform their malicious activities.

Due to the nature of interconnectivity of IoT devices, many IoT devices are exposed to various security vulnerabilities and threats. Blythe & Johnson (2018) have proposed a functional architecture of remote security management server to improve the security of the IoT devices. The remote security management server provided and managed their various security functions which allowed them to prevent and minimize some infringements incidents that occurred in the IoT environment before they can occur. Some IoT devices often lack good in-build security. Zhang & Zhang (2014) have stated that security should be designed into the devices and customers should be given some simple information at the point of purchase about the security implications of the IoT devices they are purchasing. The authors then proposed a consumer security index (CSI) which was meant to assist consumers with their decision making and incentivize greater security provision in the manufacturing of IoT devices.

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Protecting the traffic of the IoT platforms can improve security significantly. Although many protocols for the Internet have been deployed, they still need to accommodate the increasingly complex requirements of the IoT devices. Khan (2018) has proposed an open-source peer-to-peer security protocol that can be deployed in all varied environments. An analysis of the results analysis have shown the proposed protocol to be efficient in meeting the security goals in the IoT applications. Hence, such protocols need to be improved and deployed in all IoT devices to improve their security. There are some IoT security implications that have raised some concerns. IoT devices are now used in a large number of homes and offices, and this raises the risk of home invasions. The IoT devices can expose peoples IP addresses that can help invaders to get access to residential addresses. Moreover, some IoT devices send messages to the network without encryption, which raises many security bridges. Some data collected from the IoT devices such as smart TVs, speakers, printers and smart thermostats continue to be stored, transmitted, processed and sold by large organizations which can also bring more security and privacy challenges (Roman, Zhou & Lopez, 2019).

SECURITY CHALLENGES

Figure 1 illustrates the IoT devices connected through the cloud. Different IoT platforms have connected to the cloud, from industrial devices to consumer IoT devices. With respect to the 4IR, many IoT devices are being deployed which will need a connection to the cloud through secure protocols and authentication. Moreover, the security requirements of IoT devices are complex. They extend past the traditional security requirements of availability, integrity, confidentiality, non-repudiation, authentication and authorization. The forward and backward secrecy need to be incorporated in the IoT security measures.

Figure 2 shows every day used appliances that are using IoT services. Some of the appliances such as the fridge and oven have no authentication deployed which makes them vulnerable to security threats. There is a need to investigate efficient security measures that can be deployed in home appliances that may be vulnerable to attacks.

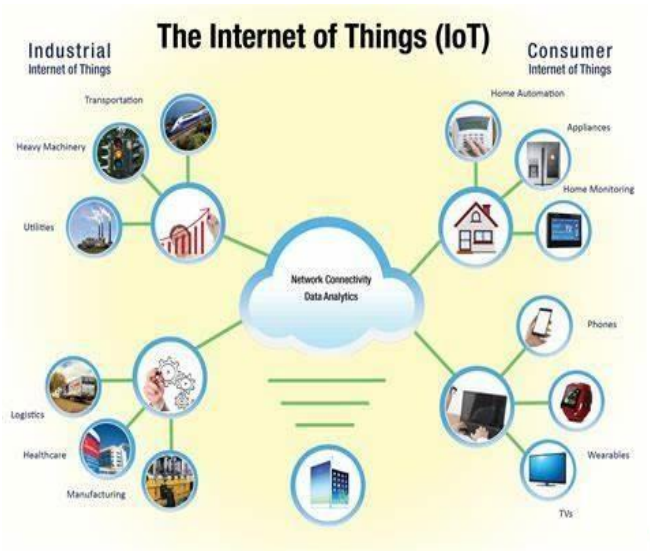

Figure 1: Internet of things

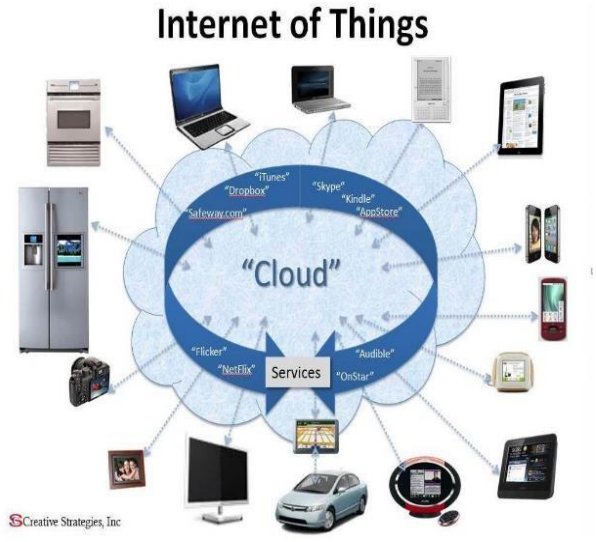

Figure 2: Internet of Things Devices

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Some of the attacks that are deployed in IoT devices are as follows:

A. Sinkhole schemes

An attacker lures traffic by presenting itself as a legitimate node to create a sinkhole. This is an attack against the confidentiality of data. It can either alter the data or drop the packets before they reach their destination. This attack can also cause other attacks such as the denial of service attack.

B. Man-in-the-middle

Cybercriminals can also launch Man-in-the-middle attacks using Internet communication protocols. Since IoT devices are manufactured to communicate, attackers can interfere with the communication by posing as a legitimate node and collect all the data. This enables the malicious actor to monitor, eavesdrop and alter the data. Attacks against the routing protocols can also be launched to alter the traffic flow, reconfigure the network topology, create routing loops, and generate false errors of modifying source routes.

C. Sybil attack In a Sybil attack

Attackers create fake nodes to mimic legitimate nodes. They use the fake nodes to generate malicious incorrect information to compromise the IoT devices.

D. Software attack

Software attacks include spoofing, cloning and unauthorized access. Spoofing occurs when a malicious user impersonates a legitimate signal to eavesdrop on the transmitted data. Cloning occurs when the attacker copies data from a legitimate tag to gain access to an IoT network. Fraudsters can often gain unauthorized access to RFID tags due to poor authentication that enables them to read, change and delete data. Attackers spoof RFID signals to read and record a data transmission from an RFID tag. In addition, attackers can use the spoofed RFID tag, then send their own data containing the original tag ID. In this way, an attacker can gain full access to the system by pretending to be the original source.

POSSIBLE SOLUTIONS

Alerting customers about the security implications of the IoT devices can improve the awareness of security in IoT devices. Individuals can be able to deploy security measures that will protect them from some security challenges, which include cyber-attacks and theft. There is also a need to adopt improved access control techniques where IoT customers prevent using weak default passwords for their devices.

CONCLUSION

The need for enhanced effective security measures for 4IR services has been realised. Researchers need to investigate security mechanisms that will protect 4IR services which include IoT and IoT devices. This paper explored some of the security vulnerabilities against the IoT devices that are already deployed by many organisations and households. We discuss thorough literature how certain individuals are not aware of the security implications of some of the IoT devices they are using. Hence there is a need that individuals be made aware of all the IoT devices being used so that they can protect themselves better against attacks.

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REFERENCES

Arseni SC, Halunga S, Fratu O, Vulpe A, and Suciu G. “Analysis of the security solutions implemented in current Internet of Things platforms”. In 2015 Conference Grid, Cloud & High Performance Computing in Science (ROLCG) 2015 Oct 28 (pp. 1-4). IEEE.

Blythe J. M. and S. D. Johnson, “The consumer security index for IoT: A protocol for developing an index to improve consumer decision making and to incentivize greater security provision in IoT devices,” in Living in the Internet of Things: Cybersecurity of the IoT - 2018, London, 2018.

Chung B., K. Jeongyeo and J. Youngsung, “On-demand security configuration for IoT devices,” in 2016 International Conference on Information and Communication Technology Convergence (ICTC), Korea, 2016.

Granjal J., E. Monteiro and J. Sá Silva, “Security for the Internet of Things: A Survey of Existing Protocols and Open Research Issues,” IEEE Communications Surveys & Tutorial, vol. 17, no. 3, pp. 1294 - 1312, 2015.

Hittu G. and D. Mayank, “Securing IoT Devices and SecurelyConnecting the Dots Using REST API and Middleware,” in 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoTSIU), India, 2019.

IEEE International Conference On Trust, Security And Privacy In Computing And Communications/ 12th IEEE International Conference On Big Data Science And Engineering (TrustCom/BigDataSE), New York, USA, 2018.

Jara A. J., “Wearable Internet: Powering Personal Devices with the Internet of Things Capabilities,” in 2014 International Conference on Identification, Information and Knowledge in the Internet of Things , Beijing, China , 2014.

Jing Q., V. Athanasios , J. Wan, J. Lu and D. Qiu, “Security of the Internet of Things: perspectives and challenges,” Springer Link, vol. 20, no. 8, pp. 2481-2501, 2014.

Khan N., N. Sakib. I. Jerin, S. Quader and A. Chakr, “Performance analysis of security algorithms for IoT devices,” in 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), Bangladesh, 2018.

Roman .R, J. Zhou and J. Lopez, “On the features and challenges of security and privacy in distributed internet of things,” Computer Networks, vol. 57, no. 10, pp. 2266-2279, 2015. . Q. Tania and L. Ruth, “Automating Legal Compliance Documentation for IoT Devices on the Network,” in 2019 IEEE 5th World Forum on Internet of Things (WF-IoT), Ireland, 2019.

Roukounaki A, Efremidis S, Soldatos J, Neises J, Walloschke T, and Kefalakis N. “Scalable and Configurable End-to-End Collection and Analysis of IoT Security Data: Towards End-to-End Security in IoT Systems”. In 2019 Global IoT Summit (GIoTS) 2019 Jun 17 (pp. 1-6). IEEE.

Seungyong Y. and K. Jeongnyeo, “Remote security management server for IoT devices,” in 2017 International Conference on Information and Communication Technology Convergence (ICTC), Korea, 2017.

Sharaf-Dabbagh Y. and W. Saad, “Demo Abstract: Cyber-Physical Fingerprinting for Internet of Things Authentication,” in IEEE/ACM Second International Conference on Internet-of-Things Design and Implementation (IoTDI), PA, USA, 2017.

Terkawi A, Innab N, al-Amri S, Al-Amri A. “Internet of Things (IoT) Increasing the Necessity to Adopt Specific Type of Access Control Technique”. In 2018 21st Saudi Computer Society National Computer Conference (NCC) 2018 Apr 25 (pp. 1-5). IEEE. Trusit S. and S. Venkatesan, “Authentication of IoT Device and IoT Server Using Secure Vaults,” in 2018 17th

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Weber R. H., “Internet of Things – New security and privacy challenges,” Computer Law & Security Review, vol. 26, no. 1, pp. 23-30, 2010.

Zhang H. and T. Zhang, “Short Paper: 'A peer to peer security protocol for the internet of things': Secure communication for the sensiblethings platform,” in 18th International Conference on Intelligence in Next Generation Networks, Paris, France, 2015.

ISBN Electronic: 978-0-6399275-6-5
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TOWARDS A FRAMEWORK FOR EXAMINING COMPLIANCE OF DIGITAL FINANCIAL SERVICE AGENTS TO LEGISLATION IN KENYA: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Aim/Purpose This paper seeks to critically assess current literature detailing the compliance of digital financial service (DFS) agent to existing legislation and standards in Kenya.

Background Using retail stores as agents to deliver financial services to customers has become a popular banking channel in developing countries, and Kenya is considered a forerunner particularly with the success of Mpesa. Despite their pivotal role, agents have so far not received much attention from empirical studies. Although challenges faced by agents have been studied, little has gone into paying wholesome attention to agents as actors and not accidental in the model.

Methodology This is an exploratory study as there have been no prior studies to the researchers' knowledge that have sought to establish agents' compliance

Contribution The most prevalent factors to DFS agents' operations and their relevance to compliance were identified from literature and used to develop a conceptual framework that can be used for empirical compliance studies among DFS agents.

Findings This research is in progress and the preliminary findings were derived through a literature review, which highlights financial and technological resources, business environment, human resources and training; and sociological factors as the most relevant to compliance.

Future Research This paper reviews existing literature and develops a conceptual framework which future research can test with empirical data.

Keywords Digital financial service (DFS); Agents; Compliance; Kenya

INTRODUCTION

Financial inclusion has been endorsed as a potent strategy to alleviate extreme poverty and a pillar for sustainable socio-economic development (Rea & Nelms, 2017). Financial inclusion refers to "access to and usage of appropriate, affordable and accessible financial services" (Klapper & Singer, 2014, p.1). Developing countries such as Kenya have low levels of financial inclusion, which is also tied to poverty, especially in rural areas (Van Hove & Dubus, 2019). To address this problem, financial technology [fintech] innovations delivering financial services at lower costs than traditional banking have been readily welcomed. One such innovation is agency banking, which has leveraged on the ubiquity of mobile technology and retail stores even in the remotest areas. The model has contributed to remarkable improvement in financial access in Kenya. However, agents face many challenges such as liquidity, lack of training and insecurity. Despite there being legislation that relates to these challenges, these challenges

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are still prevalent. This paper argues that compliance among agents can minimize challenges and affirm the credibility of the model. No compliance studies have previously been carried out among agents in Kenya. The objective of this paper is to explore current literature to gain an empirical understanding of the problem that will guide the development of a conceptual framework.

The remainder of the paper is structured as follows: the literature review methodology; reviews literature on agency banking history, legislation and compliance; presentation of the conceptual framework; and conclusions and recommendations for further research.

Definition of Terms

Digital financial services [DFS]: Use of technologies such as mobile phones, Internet, Point-of-Sale [POS] devices and magnetic strip cards to offer or access financial services. (Dara, 2018)

Agent: Retail outlets [post offices, supermarkets, gas stations, grocery shops, etc.] contracted to act on behalf of financial institutions or mobile network operators [MNO] to process prescribed financial services to customers (Dermish et al., 2012).

METHODOLOGY

Google Scholar was used as the main source for acquiring relevant literature through the University of Cape Town's library domain. Several keywords were used for the search, namely: "agency banking in Kenya"; "digital financial services in Kenya"; and "branchless banking in Kenya". The time range was 2007 to 2019. The year 2007 was considered because this is the year when the first DFS was launched in Kenya. Literature from 2015 onwards was prioritised and older sources were only used to derive critical background information. The shortlist was reduced to journal and conference proceedings articles. Papers that had no substantial focus on agents were excluded. Additional papers were obtained from reference lists of several of the identified papers. An exemption was made to include 1 unpublished dissertation and 5 concept papers and reports from key stakeholders such as the Central Bank of Kenya (CBK) for their focus on agents. In total, 21 papers were selected for analysis and synthesis, and this sample size was considered big enough to provide an overview of agents and their operational challenges, and the legislative landscape. A narrative approach to literature review was used, which focuses on mapping the current knowledge about a phenomenon with the goal of identifying existing gaps in literature (Oosterwyk, Brown & Geeling, 2019).

BACKGROUND

The Kenyan agency banking journey dates back to 2003 when Vodaphone (UK), with a grant from the Department of International Development (DFID), partnered with Safaricom (Kenya) to develop a money transfer service (Hughes & Lonie, 2007). The service, called Mpesa, was pilot-tested in 2006 with microfinance customers receiving and repaying micro-loans on their basic phones. Safaricom utilized their network of airtime resellers to perform transactions for customers. After a successful pilot, Mpesa was launched to the public in 2007 with the capabilities to deposit, withdraw, perfrom peer-to-peer [P2P] transfers, buy airtime, pay bills

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or store money without a bank account involved (Hughes & Lonie, 2007). Within the first year, Mpesa had over 1.3 million subscribers (Onsongo & Schot, 2017). Three similar products were launched in 2009 and 2010. By 2013, the number of mobile money agents surpassed the number of bank branches and ATMs in the country by nearly five times (Onsongo & Schot, 2017). Banks were affected by this rapid uptake of mobile money as their customers began storing money in their phones instead of bank accounts. After unsuccessfully trying to slow down mobile banking by declaring it a risk to financial sector stability, banks were challenged to innovate to also offer more affordable and accessible financial services to customers (Onsongo & Schot, 2017). CBK released guidelines in 2010 allowing banks to also extend financial services through agent networks.

The Role of Agents

Agents are indispensable actors without whom agency banking would not exist (Rea & Nelms, 2017). Unlike bank branches, which are capital intensive to set up and maintain, retail outlets require low capital outlay and are ubiquitous even in the remotest areas, thus making them quintessential channels for last mile delivery of financial services to the poor (Munoru, 2016). Agents facilitate transactions such as: cash deposit and withdrawal, funds transfer, account balance inquiry, bill payment and payment of government social benefits.

Agency Outlets as Organisations

Agents come in all shapes and sizes from small retail outlets, grocery shops, gas stations, pharmacies, and others. According to the description of Klein & Mayer (2011, p.7), “such merchants now operate out of small huts, shacks or rooms all across the country.” Small businesses are quick to enrol as agents for financial gain (Hughes & Lonie, 2007). Munoru (2016) estimates that 57% of agents joined to earn a profit from offering the popular services while 54% were also motivated by the fact that offering agency services attracted more customers to their primary business. Certain aspects stand out as critical factors to an agent’s delivery of financial services. They include:

i Financial resources

Agents are required to have sufficient cash and float to facilitate transactions (Katela, 2017). Making a living out of agency banking is not guaranteed and some agents depend on other economic activities to survive (Atandi, 2013; Rea & Nelms, 2017). As reported in numerous studies, lack of liquidity is a major challenge (Atandi, 2013; Githae, Gatauwa, & Mwambia, 2018; Katela, 2017; Njeru & Makau, 2014).

ii Technological resources

Agents use mobile phones, POS devices and telecommunications network to carry out transactions. Network failures and system downtimes are highlighted as a significant challenge to agency operations and the problem is more prominent in rural areas (Atandi, 2013; Katela, 2017; Onwonga, Achoki, & Omboi, 2017).

iii Business environment

Most agency outlets are in areas that would be described as ‘high risk’ (Njeru & Makau, 2014). Agents experience security risks that come with a cash-handling business (Githae et al., 2018). Unlike banks, agents do not have strict working hours and usually operate for longer hours and this increases their exposure (Katela, 2017).

iv Human resources and training

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Agents possess minimal skills to detect fraudulent transactions or authenticate originality of identification documents (Njeru & Makau, 2014). In addition, Onwonga et al. (2017) observed that some agents disclose customers' information unaware of the breach of privacy. This points to a capacity issue even though the majority of agents report as having been trained by their respective service providers (Katela, 2017).

v Socio-cultural Factors

Agents have been found susceptible to behaviours that have traditionally perpetrated social exclusion and discrimination. For instance, when there is a cash or float shortage, agents may deny services to some people while earmarking the available funds for other customers (Rea & Nelms, 2017).

Agency Banking Legislation in Kenya

Regulation in agency banking addresses risks that the innovation poses and protects customers and the entire financial system. When Mpesa launched in 2007, there was no legislation governing any financial transactions outside traditional banking in Kenya (Buku & Meredith, 2013). CBK opted for an ad-hoc 'test and learn' approach to innovation, and this has meant legislation playing catch-up with innovation (Jenik & Lauer, 2017). Some of the regulator frameworks that were developed by CBK are listed in Table 1.

Table 1. Various legislations for agency banking in Kenya (Central Bank of Kenya, 2010, 2013, 2014)

Name of Legislation	Broad Overview	Implications for agents
Proceeds of Crime and Anti-Money Laundering Act 2009	Defines money laundering and other related criminal activities	• Obligation to verify identity of customers • Obligation to identify and report suspicious transactions
E-Money Regulation 2013	Authorizes the issuing of electronic money Prescribes requirements for e-money issuers appointment of agents	• Compliance with Proceeds of Crime and Anti-Money Laundering Act 2009 • Report incidents of theft, robbery or fraud
National Payment Systems Regulations of 2014	Allows MNOs to appoint agents and states that MNOs are responsible for the actions of their agents. Requires mobile money providers to hold in trust customer funds in prudentially regulated banks Prohibits exclusive contracts between MNO/bank and agents	• Freedom to work with multiple banks and MNOs • Sufficient liquidity for each of the services offered • Requirement to be adequately trained and supported by the bank/MNO including being provided with agent manuals that contain policies and guidelines for safe and efficient customer service • Responsibility for privacy and confidentiality of customer data • Requirement to disclose terms of service such as transaction charges and customer care numbers for complaint redress • Security measures at the agent's premises

Buku & Meredith (2013) and Andiva (2015) have observed the lack of synchronicity in agency banking regulation. Andiva (2015) suggests that the reason behind the fragmentation could be due to agency banking being relatively new and Kenyan regulators having little to refer to during the drafting of policies.

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Compliance

Hopkins (1994) defines compliance as "the behaviour of the regulated in conforming with relevant regulations". It has already been established that agency outlets, which are the backbone of this model, are often microenterprises keen on making extra income. Besides their overarching financial self-interests, agents face constraints ranging from financial, technological, environmental to the kind of workforce they attract. Without proper training, agents who mostly operate in the informal sector may not understand the gravity of failing to adhere to all the regulations and standards.

Gaps Identified in the Literature

The studies reviewed fall under the four broad themes listed in Table 2.

Table 2. Literature review themes

Theme	Authors
Legislation development & implementation	Andiva, 2015; Buku & Meredith, 2013; Klein & Mayer, 2011
Social, micro & macroeconomic impact	Dermish et al., 2012; Hughes & Lonie, 2007; Kochar, 2019; Munoru, 2016; Nyagilo, 2017; Onsongo & Schot, 2017
Challenges facing agents & customers	Atandi, 2013; Katela, 2017; Onwonga et al., 2017
Agency banking adoption	Githae et al., 2018; Klein & Mayer, 2011; Njeru & Makau, 2014

Despite the crucial role they play in this model, agents have not received much attention from studies compared to other stakeholders such as customers, MNOs and banks (Peša, 2018). Agents seem to be viewed as mere platforms for the service and not as actors.

CONCEPTUAL FRAMEWORK

A review of previous agent studies has revealed a research gap in compliance. A model encompassing the seven factors identified has been developed, and this can guide the design of empirical compliance studies among DFS agents. Configuration theory proposes three parameters of understanding an organization, namely: its strategy, structure and environment (Miller, 1986). A configuration is a state where various elements have achieved a level of harmony with each other. The interconnectedness among agent business elements such as how finances affect liquidity, business location and human resources has led this study to consider DFS agents' compliance as a configuration, rather than a linear relationship leading from each factor

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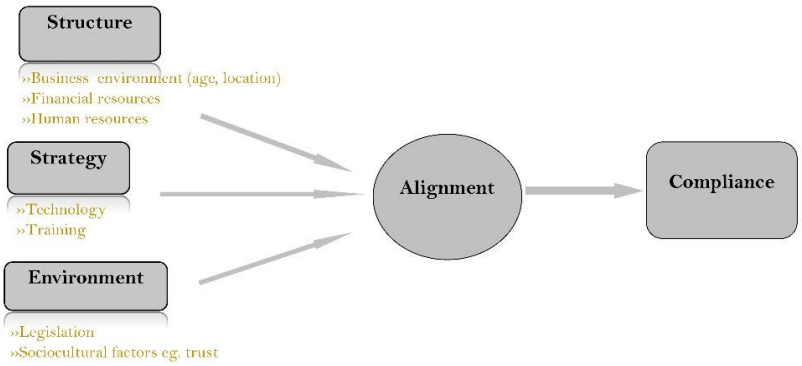

Figure 1. Conceptual Framework for examining agents' compliance

Table 3. Definition of Constructs

Structure	A description of the size of business, its age and resource distribution (Miller, 1986). This study aims to find out how each agency business is constituted and resourced.
Strategy	These are the adaptive mechanisms a business employs in order to fit into the prevailing environment such as having better technological infrastructure and quality customer service (Miller, 1986).
Environment	This is the context within which a business operates which is often characterised by the existence of competitors and governing rules and regulations (Miller, 1986). This study will focus on socio-cultural and legislative aspects of the agency banking environment.
Alignment	Venkatraman (1989) defines alignment as a level of unity among elements. This construct is not measurable but is only a representation of how various factors interact with each other and collectively influence compliance.
Compliance	Compliance is how the regulated person behaves in relation to the rules they are expected to observe (Hopkins, 1994). The parameters to measure compliance in this study are derived from the 5 legislations outlined in *Table 1*, particularly the clauses that place certain obligations on agents.

CONCLUSION

The observation that Kenya's agency banking success has not been easy to replicate in other countries remains a mystery (Buku & Meredith, 2013; Dermish et al., 2012; United Nations Inter-agency Task Force on Financing for Development, 2019). This paper suggests that a better understanding of agents and their operational compliance is vital to sustainability and replicability of agency banking. From literature review, the most important factors to agents' compliance have been identified and used to develop a conceptual framework. Further research is required to test the conceptual framework with empirical data that is expected to reveal the current state of compliance and provide insights on how agents can align their businesses along the critical factors to remain compliant. This would provide a more comprehensive picture to regulators as well as other countries that want to learn and test the model.

REFERENCES

Andiva, B. (2015). Mobile Financial Services and Regulation in Kenya. *1st Annual Competition and Economic Regulation (ACER) Conference*. Retrieved from https://www.competition.org.za/s/Barnabas-Andiva_Mobile-MoneyKenya.pdf

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Atandi, F. G. (2013). Challenges of agent banking experiences in Kenya. *International Journal of Academic Research in Business and Social Sciences*, *3*(8), 397–412. https://doi.org/10.6007/ijarbss/v3-i8/161

Buku, M. W., & Meredith, M. W. (2013). Safaricom and M-PESA in Kenya: Financial Inclusion and Financial Integrity. *Washington Journal of Law, Technology & Arts*, *8*(3), 375–400.

Central Bank of Kenya. (2010). Guideline on Agent Banking. In *Banking*. Retrieved from http://www.centralbank.go.ke/downloads/bsd/GUIDELINE ON AGENT BANKING-CBK PG 15.pdf

Central Bank of Kenya. (2013). *E-Money Regulation*. Retrieved from https://www.centralbank.go.ke/images/docs/NPS/Regulations and Guidelines/Regulations - E-Money regulations 2013.pdf

Central Bank of Kenya. (2014). *National Payment System Regulations*. Retrieved from https://www.centralbank.go.ke/images/docs/legislation/NPSRegulations2014.pdf

Dara, N. R. (2018). The Global Digital Financial Services: a Critical Review To Achieve for Digital Economy in Emerging Markets. *International Research Journal of Human Resources and Social Sciences*, *5*(1), 141–163.

Dermish, A., Kneiding, C., Leishman, P., & Mas, I. (2012). *Branchless and Mobile Banking Solution for the Poor*. *6*(4), 81–98.

Githae, L., Gatauwa, J., & Mwambia, F. (2018). Factors Affecting Uptake of Agency Banking Services Among Customers in Rural Kenya: A Case of Narok County. *European Scientific Journal, ESJ*, *14*(16), 224.

Hopkins, A. (1994). Compliance with what?: The Fundamental Regulatory Question. *British Journal of Criminology*, *34*(4), 431–443. https://doi.org/10.1093/oxfordjournals.bjc.a048445

Hughes, N., & Lonie, S. (2007). M-PESA: Mobile Money for the "Unbanked" Turning Cellphones into 24-Hour Tellers in Kenya. *Innovations: Technology, Governance, Globalization*, *2*(1–2), 63–81. https://doi.org/10.1162/itgg.2007.2.1-2.63

Jenik, I., & Lauer, K. (2017). *Regulatory Sandboxes and Financial Inclusion*. (October), 22. Retrieved from http://www.cgap.org/sites/default/files/Working-Paper-Regulatory-Sandboxes-Oct-2017.pdf

Katela, M. (2017). Challenges Facing Financial Service Agents: Case Study of Nairobi County. In *Unpublished dissertation, United States International University-Africa*. Retrieved from http://erepo.usiu.ac.ke/handle/11732/3180

Klapper, L., & Singer, D. (2014). *The Opportunities of Digitizing Payments*. Retrieved from https://elibrary.worldbank.org/doi/abs/10.1093/wbro/lkx003

Klein, M., & Mayer, C. (2011). Mobile Banking and Financial Inclusion: The Regulatory Lessons. *World Bank Policy*

Research Working Paper Series, (May), 1–34. https://doi.org/10.1596/1813-9450-5664

Kochar, A. (2019). Branchless banking: Evaluating the doorstep delivery of financial services in rural India. *Journal of Development Economics Volume 135, November 2018, Pages 160-175*, 1–19.

Miller, D. (1986). Configurations of strategy and structure: Towards a synthesis. *Strategic Management Journal*, *7*(3), 233– 249. https://doi.org/10.1002/smj.4250070305

Munoru, M. K. (2016). Effect of Agency Banking on Financial Inclusion in Kenya. *International Journal of Science and Research (IJSR)*, *5*(10), 1380–1397. Retrieved from https://www.ijsr.net/archive/v5i10/ART20162465.pdf

Njeru, B. C. W., & Makau, G. (2014). Factors influencing uptake of agency banking strategy in Kenya. *International Journal of Social Sciences and Entrepreneurship*, *1*(13), 18–36. Retrieved from http://www.ijsse.orghttp//www.ijsse.org

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Nyagilo, V. O. (2017). Financial Inclusion in Rural Kenya: An Investigation of the Role of Financial Technology as an Instrument. *International Journal of Business Management & Finance*, *1*(31), 534–553.

Onsongo, E., & Schot, J. (2017). Inclusive innovation and multi-regime dynamics : The case of mobile money in Kenya. *International Sustainabiility Transition Conference 2015*, 1–27.

Onwonga, M., Achoki, G., & Omboi, B. (2017). Challenges facing growth of agency banking in kenya: a case of kisii county. *International Journal of Research in Finance and Marketing*, *7*(6), 65–76.

Oosterwyk, G., Brown, I., & Geeling, S. (2019). A Synthesis of Literature Review Guidelines from Information Systems Journals. *Proceedings of 4th International Conference on the Internet, Cyber Security and Information Systems Internet, Cyber Security and Information Systems*, *12*, 250–260. https://doi.org/10.29007/42v2

Peša, I. (2018). The Developmental Potential of Frugal Innovation among Mobile Money Agents in Kitwe, Zambia. *European Journal of Development Research*, *30*(1), 49–65. https://doi.org/10.1057/s41287-017-0114-3

Rea, S., & Nelms, T. (2017). *Mobile Money: The First Decade* (No. Working Paper2017-1). Retrieved from https://escholarship.org/uc/item/574243f9

United Nations Inter-agency Task Force on Financing for Development. (2019). *Financing for Sustainable Development*

Report 2019 of the Inter-agency Task Force on Financing for Development. Retrieved from https://developmentfinance.un.org/report

Van Hove, L., & Dubus, A. (2019). M-PESA and financial inclusion in Kenya: Of paying comes saving? *Sustainability (Switzerland)*, *11*(3), 568–594. https://doi.org/10.3390/su11030568

Venkatraman, A. N. (1989). The Concept of Fit in Strategy Research : Toward Verbal and Statistical Correspondence. *Academy of Management Review*, *14*(3), 423–444. https://doi.org/10.5465/AMR.1989.4279078

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UP-SCALING ICT FOR DEVELOPMENT PROJECTS IN GROWING THE DIGITAL ECONOMY

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ABSTRACT

Aim/Purpose	The aim of this research is to develop and implement a scalability assessment framework founded on the comprehensive evaluation nature of an ICTD programme.
Background	According to Walsham & Sahay (2006) and (Walsham 2017), scalability of ICTD projects is one of the important topics that has been neglected. Due to a number of factors, including the lack of a proven business model for success, the high failure rate of such projects, and the small number of projects that have in fact been scaled-up, little has been written about scalability and the sustainability of such projects (Roma & Colle 2005; Walsham &Sahay 2006; Walsham 2017). Scalability has multiple definitions, but it can generally be defined as a process that entails the expansion of the size and scope of a project, the adaptation of a project to the context or community, sustaining of desired policy, program and practice changes, and the implemented projects in different places, in order to reach a greater number of people and communities, whilst working towards replication (Batchelor & Norrissh, 2005; Walsham & Sahay, 2006; Gerhan & Mutula, 2007; Walsham et al., 2007; Hartmann & Linn 2008; Saebo & Thapa, 2012; World Bank, 2012; Fox, 2016). Implied in definitions of scaling-up is the assumption that a project is scaled-up to achieve valued outcomes, such as poverty reduction, or the goals of a country and World Bank strategies (World Bank 2012). Untapped opportunities exist to multiply and scale-up successful pilot projects and approaches. Up-scaling may also imply increasing benefits. A participative ICT approach involving needs assessment and impact monitoring specialists make a difference when scaling-up (Gerster & Zimmermann, 2005; Pade-Khene 2016). However, Uvin, Jain & Brown (2000) argue very strongly that up-scaling development projects should be based on expanding the impact of the project rather than trying to achieve a larger project that spans large regions without any impact. This should be done to avoid the success of small development projects operating in small 'islands of excellence' in a space of wider development inequalities that mostly affect marginalised areas (Uvin, Jain & Brown, 2000).

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	Linn (2012) asserts that the process of scalability is generally not linear, but an iterative and interactive cycle as the experience from scaling-up feeds back into new ideas and learning. Hosman (2008) indicates that the topic of scalability should also encompass ICTD capacity building activities, which include issues of affordability, accessibility and awareness of the intended audience. Scalability assessments could also be conducted in to increase the complexity of services offered over a period of time in order to respond to people's growing and changing needs (Walsham, Robey & Sahay, 2007, p.323). In the case of development, up-scaling generally refers to increasing the size, outreach and deepening of the impact, which can be vertical, horizontal or a mix of both (Meegammana et al., 2009). Vertical up-scaling is defined as increasing the impact of the project within its existing context (Gillespie, 2004; Gerster & Zimmermann, 2005; Meegammana *et al*., 2009). Some examples of up-scaling the project vertically include an increased volume of content, new added subjects, enhanced software and interfaces, improved content quality and usability to deepen the learning impact, and catering for more user groups (Laitinen, Fayad & Ward, 2000; Meegammana et al., 2009). Vertical up-scaling also refers to other activities related to the same chain of activities as the original one, which are added to an existing program (i.e., upward or downward linkages are made) (Gillespie, 2004). Horizontal up-scaling on the other hand deals mainly with increasing outreach to increase the number of people or social groups benefiting; which also overlaps with increasing geographic coverage through replication. However, horizontal up-scaling differs when looked at from the perspective of a single locality whereby it increases the number of people using an existing system (Gillespie, 2004; Meegammana et al., 2009). Horizontal up-scaling also represents new unrelated activities that are added to existing programs, or new programs that are undertaken by the same organization. Both forms of up-scaling are generally functional in nature, as they focus on achieving scale within the desired project. Therefore, both vertical and horizontal up-scaling are parallel processes and are equally important to increase usage and the number of people who are able to benefit, which then assists in improving impact and sustainability of the project (Meegammana et al., 2009). However, up-scaling is not only about quality of impact, scale and sustainability; in practice, it involves a multidimensional process of change and adaptation. The approach of up-scaling should be based on a comprehensive approach. According to Rossi, Freeman & Lipsey (2004), programme evaluation is a process that aims to provide evidence about the effectiveness of social intervention programmes, in order to aid and assist decisionmakers on the possibility of continuing, expanding, improving or discontinuing a programme. This is applied through the availability of information that is collected in a 'robust' or 'comprehensive' manner that analyses, interprets and communicates the collected information to the necessary stakeholders (Rossi, Freeman & Lipsey, 2004; Pade-Khene & Sewry, 2011). There are a number of domains of evaluation that need to be to be conducted,

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	which will then provide comprehensive information on the status of the programme and how if possible, it can then be scaled up. Therefore, the decision to scale is not to be taken lightly; it should not only be based on the information conducted from an impact assessment, but on other domains which informed the setup of the project at the inception stages and the progress made throughout the project. In the Information Systems discipline, comprehensive evaluation has been documented as a process that involves reviewing the contribution of the proposed idea to the business strategy, the costs involved, testing the business idea, flexibility, risk involved, and so forth (Pandey & Gupta, 2018). In the ICTD field, comprehensive evaluation refers to the need to assess a project in a holistic manner that assesses how a project has performed. Unfortunately, a number of ICTD projects have failed in this manner to produce evidence of how they have contributed to the impact on socio-economic conditions (Mthoko & Khene, 2018). Through the review of the literature, different authors have various approaches to provide evidence for conducting the necessary evaluation in a comprehensive or holistic manner. To guide the review of the necessary domains in the process of basing a scalability assessment framework on a comprehensive evaluation process, the Rural ICT-Comprehensive Evaluation Framework (RICT-CEF) is used as a base guide of the necessary proceeding domains of evaluation in an ICTD project. The motivation to use the RICT-CEF is based on its unique design, premised on evaluating rural ICT projects. The comprehensive nature of the RICT-CEF and its ability to integrate and make an assessment from the inception of the project to the end. The outcome of the various domains of the RICT-CEF contributes to the decision of whether or not to scale the project can be scaled. To advance the digital economy, the understanding of scaling a project becomes imperative for the advancement of the digital skills agenda.
Methodology	This research will be conducted using the Design Science Research paradigm. The paradigm is viewed as the most suitable approach to creating, applying, and reflectively evaluating an artefact developed for assessing the scalability of ICTD projects (Hevner et al., 2004; March, Park &Ram, 2004). The design science process is iterative, using a rigorous process of theoretical analysis to develop the Comprehensive Scalability Assessment Framework, and an iterative process in the field to reflect on its relevance (Hevner et al., 2004; Peffers et al., 2007; Tuunanen, Rothenberger & Chatterjee, 2007; Islam & Grönlund, 2012). The case study strategy will be used to explore the Scalability Assessment framework. The case study design provides a conceptual framework that links the empirical data to be collected and conclusions to be drawn to the preliminary research questions proposed for the study (Yin, 200). The use of a case study as the research strategy assists in observing scalability assessment in order to identify any shortcomings of the framework. The research will be conducted in a project that is currently operating in South Africa and has the intention to be up-scaled. The Technology for Rural Education Development project (TECH4RED)

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	with a particular focus on the ICT for rural education development (ICT4Red) aspect will be used for this research. The TECH4RED project is implemented and facilitated by the Council for Scientific and Industrial Research (CSIR) Meraka Institute in collaboration with several government departments (Ford, 2013). The aim of the TECH4RED project is to investigate the viability of providing electronic textbooks and other educational digital content resources to 26 schools in the Nciba Circuit of the Cofimvaba School District (Ford, 2013). Ultimately, the project is aimed at enabling recommendations and models towards scaling the different spheres of the project in other areas in the district, province, and on a national basis (Ford, 2013). A qualitative approach will be used to collect data to reflect on the application of the Scalability Assessment Framework. Instruments that will be used include observations, semi-structured interviews, focus groups and documentation analysis. The data collected will then be reviewed against the scalability assessment framework applied in TECH4RED to guide its revision iteratively.
Contribution	The contribution of this research is in the continued development of the body of knowledge of the ICTD field in efforts to reduce the number of projects that are scaled without a comprehensive evaluation on their ability to scale-up. The development of a scalability assessment framework also contributes to the body of knowledge through providing a methodological framework that aims to solidify a flexible process in order to provide evidence.
Findings	The process of assessing scalability in ICTD projects in the digital economy should be conducted in a comprehensive manner that is able to take into account the importance of evaluation, and to make decisions with the input of all stakeholders while taking into account all contextual factors and the assessment of the project. The Comprehensive Scalability Assessment Framework is developed based on a critical review of the field and its frameworks. This proposed framework is structured in a manner that uses assessment guidelines throughout the assessment process; it incorporates the results of the comprehensive evaluation and thereafter sets in motion a scalability assessment plan that contributes to the final scalability judgement. At the centre of the proposed framework are the four themes that make-up the scalability assessment, namely: '*Stakeholder composition*', '*Resource sustainability*', '*Resilience*', '*Model feasibility*', and '*Judge scalability*'. A system analysis diagram is the main output of the judge scalability stage and is interpreted to make a decision to scale-up the project or not. The proposed framework, therefore, aims to provide a comprehensive report that decides on the scalability of the project based on the gathered information and evidence, to actively decide with all stakeholders if the project should be scaled-up or not. In order to have a clearer view and understanding of the suitability, practicality and shortcomings of the proposed framework, it is important to apply the framework in a real-life setting and use the results of the implementation to revise the proposed framework.

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Recommendations for Practitioners	Other than flexibility, this research provides guidelines on how to conduct the assessment through a step-by-step process. More importantly, it emphasizes the need for practitioners to be thorough when conducting a comprehensive evaluation before undertaking an assessment. A comprehensive approach in the digital economy would ensure adequate assessment in terms of understanding the needed technology, the capacity to ensure the scaled project will work and ongoing motivation to see the project function (Toyama, 2015).
Recommendations for Researchers	A number of research projects are conducted and scaled-up due to the pressure of the funders. This research assists in providing concrete steps on how the scaling-up process should happen based on proper evaluation. This scaling-up process provides insight into the usability and applicability of using design science to provide usable artefacts for researchers. This research has also developed scaling theory that will influence how researchers assess projects.
Impact on Society	The projects that are conducted in the ICTD environment can now provide evidence that enables a thorough assessment of the scale-up potential of the project that is comprehensive in nature before funds are spent on projects with a high risk for failure. This research study will ensure projects that are scaled-up to advance the digital space, have been thoroughly assessed so that they are underpinned on capacity, access and motivation. A digital economy that has growing digital skills acquired from ongoing scaled-up training projects will enhance the community, through the increased number of digital citizen through scaled impact.
Future Research	The limitation of this research is that the framework has undergone one round of iteration, and more iterations would enhance its applicability. Future research could be conducted by enhancing the proposed framework through implementation in other contexts of ICT projects. Such research could provide cases of empirical evidence and additional approaches for analysing the results of the framework when it is implemented in other areas.
Keywords	Scalability; Digital economy; Development projects; ICTD

REFERENCES

Batchelor, S. and Norrish, P., 2005. Framework for the Assessment of ICT Pilot Projects. Washington: Info Dev.

Ford, M., 2013. TECH4RED Enhancing Education. Pretoria: CSIR Meraka Institute.

Gerhan, D.R. and Mutula, S.M., 2007. Testing a Recent Model of ICT in Development: Botswana and Its University. Information Technology for Development, 13(2), pp. 177-197.

Gerster, R. and Zimmermann, S., 2005. Up-Scaling Pro-Poor ICT-Policies and Practices. Switzerland: Swiss Agency for Development and Cooperation.

Hartmann, A. and Linn, J., 2008. Scaling Up: A Framework and Lessons for Development Effectiveness from Literature and Practice. Wolfensohn Centre for Development Working Paper No. 5, Washington DC.

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

Hosman, L., 2008. A Pilot Takes Off: Examining Sustainability and Scalability in the Context of a Sri Lankan Public-Private Partnership Telecenter Project, Proceedings of the 19th Australasian Conference on Information Systems, 3-5 December 2008.

Laitinen, M., Fayad, M. and Ward, R.P., 2000. The problem with scalability. Communications of the ACM, 43(9), pp. 105-107.

Meegammana, N., Sampath, R., Khrishna, M.V., Chamara, G., Dhanajaya, S. and Pradeep, G., 2009. Up-scaling and Replication? 150 Experiences. Colombo, Sri-Lanka: The Shilpa Sayura Research Foundation.

Pade-Khene, C. and Sewry, D., 2011. Towards a Comprehensive Evaluation Framework for ICT for Development Evaluation – An Analysis of Evaluation Frameworks, 2nd International Conference on Information Management and Evaluation (ICIME), 27-28 April 2011, Ted Rogers School of Management.

Peffers, K., Tuunanen, T., Rothenberger, M.A. and Chatterjee, S., 2007. A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems, 24(3), pp. 45-78.

Roman, R. and Colle, R., 2005. Notes on Research for Telecenter Development. In: A. BADSHAH, S. KHAN and M. GARRIDO, eds, Connected for Development: Information Kiosks and Sustainability. Illustrated edn. New York: United Nations, pp. 89-96.

Rossi, P.H., Lipsey, M.W. and Freeman, H.E., 2004. Evaluation: A Systematic Approach. First edn. Thousand Oaks, California, London: SAGE.

SAEBO, O. and THAPA, D., 2012. Towards scalability of ICT4D projects: a salience stakeholder perspective, Proceedings of SIG GlobDev Fifth annual Workshop, 16 December 2012.

Toyama, K., 2015. Geek heresy: Rescuing social change from the cult of technology. Public Affairs.

Uvin, P., Jain, P.S. and Brown, L.D., 2000. Think large and act small: Toward a new paradigm for NGO scaling up. World Development, 28(8), pp.1409-1419.

Walsham G., Robey, D. and Sahay, S., 2007. Special Issue on Information Systems in Developing Countries. MIS Quarterly, 31(2), pp. 317-326.

Walsham, G. and Sahay, S., 2006. Research on information systems in developing countries: Current landscape and future prospects. Information Technology for Development, 12(1), pp. 7-24.

Walsham, G., 2017. ICT4D research: reflections on history and future agenda. Information Technology for Development, 23(1), pp.18-41.

World Bank, 2012. Lessons from Practice: Assessing Scalability. Washington DC: The World Bank.

Yin, R.K., 2003. Case Study Research Designs and Methods. Third edn. Los Angeles: SAGE.

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FROM KEY DRIVERS TOWARDS A FRAMEWORK FOR MEDIA LITERACY TRAINING

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ABSTRACT

Aim/Purpose The aim of this research was to design a Media Literacy Framework – informed by identified media literacy indicators within a South African context – which can be used as guideline to develop a Media Literacy curriculum that aligns with the vision of the National Electronic Media Institute of South Africa (NEMISA, 2017) and the 2013 National e-Skills Plan (NeSPA) (DOC, 2013) to have an e-skilled nation by 2030.

Background According to NEMISA (2017, 2020), the foundation of e-skills is digital literacy (or e-literacy), which can be summarised as the capability that individuals have to utilise 'all things digital' for doing tasks, solving challenges and problems, communicating, dealing with and managing information, as well as joining resources through cooperation, generating and sharing information, and creating knowledge in one's daily life and working environment.

Digital literacy training for the nation currently consists of various components such as computer literacy, Internet and emails, and mobile literacy (Lombard, 2020). Media literacy is perceived as another prospective component of digital literacy. In essence, media literacy refers to the competency of individuals to access both printed and digital forms of media, to display critical thinking in order to contextualise messages, and to create and convey mediated messages to others (NAMLE, 2020), i.e. being astute consumers and producers of information.

In a study on media literacy indicators, Jordaan & Lombard (2019) developed a Media Literacy Drivers (MLD) Model, derived from previous research conducted by Thoman& Jolls (2006), who posed five critical questions on media literacy, and then answered these questions by proposing five core concepts crucial to an individual being perceived as media literate. The MLD model of Jordaan & Lombard (2019) consists of five key indicators, each encapsulating a number of smaller indicators.

Methodology A comprehensive literature review was conducted on media literacy frameworks existing globally, and this information, together with the research outcomes of Jordaan & Lombard (2019) study on media literacy indicators, was used to develop a Media Literacy Framework.

Contribution This Media Literacy Framework can be used as guideline for designing and developing a media literacy curriculum to roll out a fourth component of digital literacy training within a community context across South Africa.

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Findings	The following key findings were derived: • Existing media literacy frameworks across the globe are not Media Literacy Framework for Training customized to include a community context relevant to the South African perspective; and • Communities in South Africa may differ in terms of e-skills and digital literacy competence, and one major factor of this may be attributed to the lack of technology access in areas where connectivity is still a major challenge.
Recommendations for Practitioners	The Media Literacy Framework has been designed as guideline for Practitioners to develop a media literacy curriculum, and guidelines offer flexibility to a certain extent. Practitioners should therefore take into consideration that the media literacy curriculum might have to be adjusted depending on the level of technology access available to the learner in a specific region.
Recommendations for Researchers	Further research could be conducted to test the soundness of the proposed Media Literacy Framework through an impact study where a media literacy curriculum, developed using the Framework as guideline, is used as the intervention
Impact on Society	By training communities to become media literate, the communities will be more prepared and able to identify fake news, analyse and evaluate messages, and create and distribute their own mediated messages, thereby contributing to enhancing the economy and governance of their own communities and the country at large.
Future Research	Now that a customised Media Literacy Framework has been designed, the next step is to use the Framework as guideline to develop a media literacy curriculum specifically for training communities in South Africa.
Keywords	Media literacy; Media literacy indicators; Media literacy framework; e-Skills; Digital literacy.

REFERENCES

DOC *see* South Africa. Department of Communications.

NAMLE see National Association for Media Literacy Education.

NEMISA *see* The National Electronic Media Institute of South Africa.

Jordaan, A. & Lombard, A. (2019). Key drivers to enhance media literacy in the community. *Proceedings of the Digital Innovation and Transformation Conference: Digital Skills 2019, 27-28 August 2019, Johannesburg, South Africa.*

Lombard, A. (2020). Interview with the Northern Cape and Southern Gauteng CoLab Director at Vaal University of Technology, Sebokeng Campus, Gauteng.

National Association for Media Literacy Education. (2020). Media literacy defined. Retrieved January 21, 2020, from https://namle.net/publications/media-literacy-definitions/

South Africa. Department of Communications. (2013). *National e-Skills Plan of Action (NeSPA) 2012: Continuing e-skilling the nation for equitable prosperity and global competitiveness in the knowledge society*. Pretoria: Department of Communications and the Information Society Institute. February.

The National Electronic Media Institute of South Africa. (2017). *Value proposition: An e-skilled nation*. Johannesburg: NEMISA. Retrieved January 7, 2020, from http://www.nemisa.co.za/insight-and-links/

ISBN Electronic: 978-0-6399275-6-5
ISBN Print: 978-0-6399275-5-8

The National Electronic Media Institute of South Africa. 2020. NEMISA Home Page. Retrieved December 12, 2019, from http://www.nemisa.co.za/

Thoman, E. & Jolls, T. (2006). *Literacy for the 21st century: An Overview and Orientation Guide to Media Literacy Education*. Centre for Media Literacy.

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POSTERS

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A Central Process Management repository and workflow system for Provincial Government: *A Focus on the Eastern Cape*

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Kobe Institute of Computing
Graduate School of Information Technology

Introduction

Background of the study

A business process is a set of linked activities which collectively transform inputs into outputs that deliver value to a service beneficiary. The management of these business processes can be described as a well-organized method to classify, design, implement, document, quantity, and govern all forms of business processes to accomplish steady, targeted outcomes aligned with the organizational strategic goals and service delivery model [1]. In the context of business process management, a central repository and workflow system can be defined as a single nexus for easy access to processes and management thereof [2]. This platform serves as a single source of standardized information about processes of an organization.

ICT landscape in South African public sector

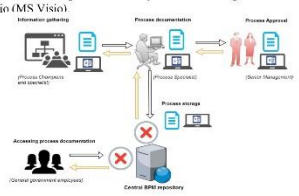
According to the National Development Plan (NDP): Vision for 2030, there is an urgent need to build a capable state that strives to improve the quality of service provided to citizens [3]. One the key pillars was highlighted as digital transformation of the public service [3]. The South African (SA) government has various policies and statutory bodies that allow a much more conducive environment for the introduction of ICT Innovations and interventions. These include Government Information Technology Officer's Council (GITO), State Information Technology Agency (SITA), and Department of Public Services and Administration (DPSA) in charge of implementing and facilitating e-Government and Information and Communication Technology (ICT) projects at government institutions. Additionally, in the year 2006 the South African government adopted a Free Open Source Software (FOSS) policy [4].
The Global IT Report ranks the ICT environment in SA 33rd out of 139 nations. These rankings include business & innovation, political and legislative framework [5] Furthermore, ICT usage in government is ranked at 105th and ICT social impact 112th out of 135 countries [5]. This is an indication that much needs to be done in terms of e-Government initiatives, most particularly Government-to-Government (G2G) programmes. These programmes are aimed at increasing internal operations of government entities to reduce inefficiencies and service delivery costs [6].

BPM in South African public sector

From the year 2011 to 2016, the DPSA has developed and revised the Operations Management Framework for public service delivery [7]. In the framework, one of the key building blocks for operations design is business process management and it forms an important part of the South African government operations management value chain for public service.

Problem Statement

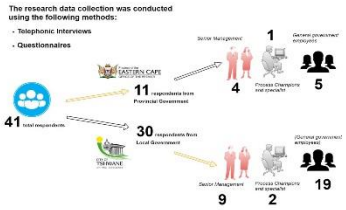
Despite the creation of an enabling environment through regulatory frameworks and support mechanisms both internally and externally, departments still find it difficult with the continuous improvement and delivery of quality services to citizens [8]. The Eastern Cape Provincial departments are unable to map services provided to ensure effective and efficient delivery. These processes are either undocumented or they are documented using a standalone process modelling tool like Microsoft Visio (MS Visio).



Methods

The objectives of the research was to increase service quality and the ability for Eastern Cape provincial departments to continuously improve operations. Additionally, to create a centralized process repository for the Eastern Cape provincial departments. Furthermore, the research envisages to enable the Eastern Cape provincial departments to record data about risks and potential improvements of each process using standard operating procedures.

This study followed the survey method – which in essence questions individuals and describe certain aspects or characteristics of a population. The method was most appropriate for testing the notion of Business Process Management in Government, reflecting on the attitude of concerned population, and establish the level of satisfaction with current situation.

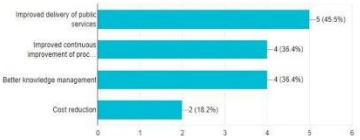


Results

In order to obtain more clarity on BPM implementation in the two government organizations, respondents were asked about the method of mapping and documentation of processes within their various departments. 81,8% of the respondents confirmed that they are using MS Visio or word to map and document processes, whilst remaining used paper(9,1%) and others said they not mapping or documenting their processes(9,1%).

We further examined by asking respondents what are the possible root-causes resulting to the aspects considered as risk areas. This was based on the aspect each respondent identified as problematic. 72,7% said the flow of documents during the processes, whilst 18,2% said it's the interactions with other systems in the processes and 9,1% said there are many dependencies that affect how the processes flow.

Respondents were asked which aspect or area of the organization would be improved due to the introduction or adoption of central process management system. 45,5% confirmed that it would improve delivery of public services, on the other hand 36,4% evenly confirmed that it will improve continuous improvement of processes. 18,2% said it would reduce costs.



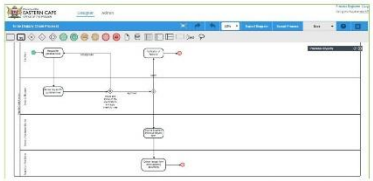
Conclusions

Recommendations for future work

BPM is still a fairly new phenomenon is government, most especially at Provincial level. This can give rise to challenges such as awareness and training of BPM in provincial departments. Standard operating procedures play an essential role in understanding how processes are performed, by who, when, and where.

The recommendation for future work should consider the aforementioned. The first recommendation is to evaluate the effectiveness of the solution onsite at one of the Eastern Cape provincial departments with actual potential users. The second recommendation is an additional functionality for standard operating procedures should be included in the central process management repository. The third recommendation would be creating impactful awareness and training internally at the provincial government. If the solution has proven to be effective, then implement it in other departments but take into consideration complexities such as change management and project management.

In summary, the central process process management repository and workflow is expected to reduce turnaround time contributing to an improved delivery of public services.



Bibliography

[1] Association of Business Process Management Professionals, Guide to the Business Process Management Common Body of Knowledge, 2013.
[2] C. Thiemich and F. Puhlmann, "An Agile BPM Project Methodology," in *International Conference of Business Process Management*, Beijing, 2013.
[3] National Planning Commission, "National Development Plan: Vision for 2030," National Planning Commission, Pretoria, 2011.
[4] Department of Public Service & Administration, "Policy on Free and Open Source Software use for South African Government," Department of Public Service & Administration, Pretoria, 2006.
[5] World Economic Forum and INSEAD, "The Global Information Technology Report," World Economic Forum and INSEAD, Geneva, 2016.
[6] Department of Telecommunications and Postal Services, "National Integrated ICT Policy White Paper," Department of Telecommunications and Postal Services, Pretoria, 2016.
[7] Department of Public Service and Administration, "2016 Operations Management Framework," Department of Public Service and Administration, Pretoria, 2016.
[8] L. Khuboni, "Operations Management [PowerPoint Slides]," 28 January 2016. [Online]. [Accessed 30 August 2017].

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Digitalisation for Self-regulated Vehicles via the Internet of Things

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Vaal University of Technology

Introduction

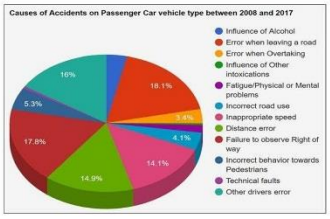
Continual increase of vehicles on road networks, alongside the human factor, necessitated the integration of the Internet of Things (IoT) driven by reliable communication technology incorporated within Intelligent Transport Systems (ITS) to conform within the autonomous vehicle arena.

This research aims to explore the realm of IoT and how it is integrated into self-regulated vehicles and other applications from a pragmatic standpoint. Application of contemporary data network facilities are demonstrated with detection and communication techniques such as machine learning to develop an effective IoT solution. An IoT model was constructed encompassing vehicular network technologies, based on empirical simulation to explain and substantiate the operation of system.

Background

Any network of objects such as vehicles, combined with electronic devices such as sensors and software connected via a communication system, are encompassed within IoT (Ashton, 2009), allowing a more direct integration of the physical world with information systems, thereby reducing human interference with ensuing efficiency, accuracy and economic viability.

Figure 1: Causes of accidents between 2008 and 2017 (Source: Khaliq et al., 2019)



Vehicle ad-hoc systems (VANETS), through Artificial Intelligence, have improved efficiency of cross-vehicular communication and can thus perform best-route calculations on the fly based on real-time events that transpire while in transit to a destination.

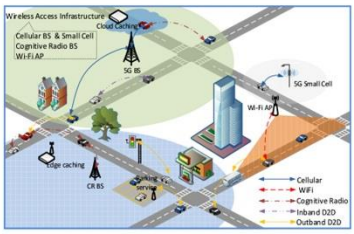
Routing

Reviewing V2V communication using VANETs, Abbasi and Kahn (2018) considered position-based protocols as opposed to topology-based protocols in urban settings, due to frequency of environmental topology changes. Insight is drawn to routing in forwarding techniques, means of junction selection, and methods of dealing with local peak traffic situations. Simulation of dynamic junction selection and static junction selection-based routing protocols was demonstrated. Researchers verified that for effective routing protocol, certain characteristics of VANETs resulted in unreliable communication. They claimed that high mobility and intermittent connectivity affected linkage and subsequent loss of packets within a network that fluctuates from congested to sparse. Researchers also felt that these attributes made security challenging, and established that the existing urban real-life environment is not suitably reflected in present routing VANET protocols and position-based protocols.

Zhang *et al.* (2016) propounded a congestion-aware routing algorithm to route a fleet of autonomous vehicles in a coordinated manner that does not increase congestion. Simulation demonstrated that routing and rebalancing (empty vehicle trips between drop-off and next collection) of self-regulated vehicles in a coordinated manner in Manhattan that provided mobility-on- demand service to customers could reduce pollution, demand for parking, and cost of travel.

Once a customer is serviced, the vehicle drives itself to the next customer and the network ensures that the proportion entering each node is equivalent to the proportion exiting node. Rebalancing therefore did not increase the total number of self-regulated vehicles on the road, as they were intelligently routed to avoid increasing congestion by optimising routes of both passenger-carrying and empty vehicles.

Figure 2: Wireless access infrastructure (Source: Cheng & Shen, 2016)



Other researchers also postulated that in managing a fleet of self-regulated vehicles, the mobility-on-demand system could help reduce capacity if multiple rides are serviced with a single trip. A New York study by Santi *et al.* (2014) showed that a taxi trip shared by two riders in Manhattan increased travel time in 80% of cases by only a few minutes, which was later verified by Alonso-Mora *et al.* (2017).

Method

By employing IoT vehicular technology, a computer model was designed and built representing the real-life environment to demonstrate through algorithms how the concept would function. Simulation models can be used to verify theory (Olivier, 2011). While computer security was addressed in line with Construct Theory and theoretical predictions, a simulation was performed and the results were analysed. As a requirement in computer simulations (Gulyás & Kampis, 2015), replication testing was performed using different data input.

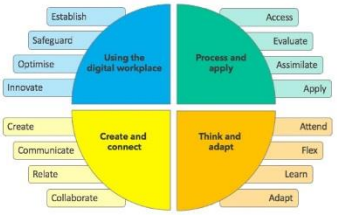
Digitalisation

"Digitalisation can inter alia be defined as the adoption of digital technologies to modify a business model. The aim is to create a value from the use of new, advanced technologies by exploiting digital network dynamics and the giant digital flow of information" (IGI Global, 2020).

Digitalisation beyond the discipline of the Internet of Things primarily refers to human-generated (digital) information and centralised autonomous systems. It creates digitisation of the physical world through dynamic and disseminated computation and algorithms into devices which humans are becoming more naturally dependant on.

Concerns are raised about Artificial Intelligence and human activity, cybersecurity and privacy, justifying an appetite for new skills and development. Digitalisation is knowledge gain: it encompasses understanding and application. As a foundation for *Design Thinking*, digital literacy holds responsible those who benefit from using the technology (Knitl & Erdebil, 2019).

Figure 3: Workplace Digitalisation (Source: Marsh, 2018)



Results

The experiment conducted in this research conformed to expected behaviour with similar outcomes in the analysis of repeat tests, thereby verifying initial results. This equated to the consolidation of the virtual world and the real world through computation and theoretical reasoning (Sastry, 1997).

Future Research

Further research is needed in the following areas:

- VANET routing performance, as environmental characteristics are not accurately reflected (Abbasi & Khan, 2018)
- Security research in multi-faceted IoT automotive computer systems with possible in-built repair systems
- VANET communication in an infrastructure-less environment to prepare assimilation of vehicular networks with 5G mobile technology

Bibliography

Abbasi, I. A. & Kahn, A. S. (2018). *A review of vehicle to vehicle communication protocols for VANETs in the urban environment*. Future in Internet. http://www.mdpi.com/journal/futureinternet [3/12/2018].

Alonso-Mora, J., Samaranayake, S., Wallar, A., Frazzoli, E. & Rus, D. (2017). On-demand high-capacity ridesharing via dynamic trip-vehicle assignment. *Proceedings of the National Academy of Sciences (PNAS)*, (114):462–67.

Ashton, K. (2009). *That 'Internet of Things' thing*. http://www.rfidjournal.com/articles/view?4986 [11/11/2017].

Cheng, N. & Shen, X. (2016). *Introduction in: Opportunistic Spectrum Utilization in Vehicular Communication Networks*. https://link.springer.com/chapter/10.1007/978-3-319-20445-1_1 [03/01/2020].

Gulyás, S. I.. & Kampis, G. (2015). Models, representations and comparisons in computer simulations. *Proceedings*. 4th International Young Scientists Conference on Computational Science. *Procedia Computer Science*, (66):5–12.

IGI Global. (2020). *What is digitalisation*. https://www.igi-global.com/dictionary/it-strategy-follows-digitalization/7748 [19/02/2020].

Khaliq, K. A., Chughtai, O., Shahwani, A., Qayyum, A. & Pannek, J. (2019). Road accidents detection, data collection and data analysis using V2X Communication and Edge/Cloud Computing. *Electronics*, 8:896.

Knitl, W. & Erdebil, N. (2019). *Spring2Innovation: Internet of Things and Design Thinking pave the way to digital literacy*. http://www.spring2innovation.com/2019/06/internet-of-things-design-thinking-pave-the-way-to-digital-literacy/ [15/01/2020].

Marsh, E. (2018). *The Digital Workplace Skills Framework ensuring the workforce is ready to work digitally*. Digital Work Research. https://digitalworkresearch.com/wp-content/uploads/2018/08/The-Digital-%20%20Workplace-Skills-Framework-final.pdf [18/01/2020].

Olivier, M. S. (2011). *Information technology research: A practical guide for computer science and informatics*. 3rd ed. Pretoria: Van Schaik.

Santi, P., Resta, G., Szell, M., Sobolevsky, S., Strogatz, S. H. & Ratti, C. (2014). Quantifying the benefits of vehicle pooling with shareability networks. *Proceedings of the National Academy of Sciences (PNAS), (111):13290 94.*

Sastry, M. A. (1997). Problems and paradoxes in a model of punctuated orgamisational change. *Administrative Science Quarterly*, 42(2):237–275.

Zhang, R., Rossi, F. & Pavoni, M. (2016). *Routing autonomous vehicles in congested transportation networks: Structural properties and coordination algorithms*. arXiv:1603.00939v2. Stanford University.

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Designing a Big Data Analytic Career Choice Framework for Grade 12 Learners: A Case of the Eastern Cape Province

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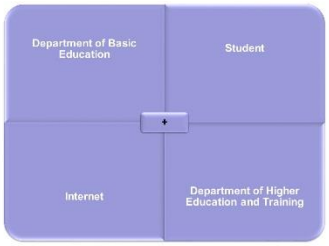
Introduction

- The study will focus on the formulation of a framework to guide the creation and utilisation of a recommender system, which will be guided by the analytics of a **student's personal information,** their **online activities, personal interests, family details** as well as **academic information** in order to make more informed decisions in choosing the most ideal or ultimate course to enrol for.
- All consolidated and analysed big data will be used in creating a detailed profile of a student, which will not only assist the student in choosing a study programme leading to their future career.

Expected Contribution

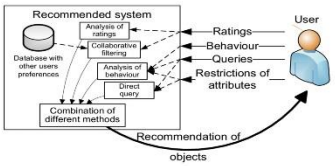
- The study proposes the utilisation of students' big data in creating a career recommender system for Grade 12 school learners with an aim to assist learners in choosing a suitable career path.
- The proposed framework will not only assist high schools, tertiary institutions as well since these prospective tertiary learners will be enrolled for suitable courses, which they have interest in, this will create highly motivated and passionate students.
- Institutions of higher education will be less likely to experience a high dropout rate, or student's changing courses in their year or semester of enrolment. Students will also be self-aware of their abilities and interests that they may have not been previously aware of.
- This study will utilize all available student data in order to best recommend an ideal programme of study. The study also aims to determine the motivation behind and perceptions of students when they choose careers and possible occupations they think are best for them.

Entities Involved



Big Data Sources

Recommender System



Methodology

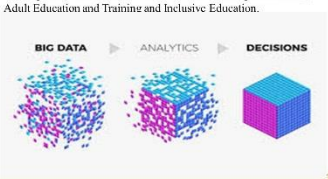
- The study will adopt a mixed method approach, where both qualitative and quantitative methodologies will be used. A sample of Grade 12 learners from High Schools in different districts within the Eastern Cape province will be the main participants in this study.
- A survey questionnaire will be sent out to the schools. Teachers and parents will form part of the participants in this study.
- Interviews will also be conducted to get more information on the variables to be investigated.

Reasons for interest in the topic

- Institutions of higher learning are currently faced with a **high failure rate** and **dropout rate**, which I believe a majority of these problems can be avoided.
- Many students are enrolled in courses they **don't have enough knowledge of,** they don't like or have interest in, and this leads to less motivated students who struggle through their courses.
- This puts the **students at risk** of not making it through their studies from the very beginning of their tertiary life. There are various reasons students end up choosing the least favourable course to do, such factors will be discussed in this study,
- Additionally, discovering other factors that play a role in a student's decision in the career path they choose will help in making sure that all external contributors are known and given attention.

Data Availability

- The data to be used in the study is available with the Department of Basic Education.
- All data available linked to a student will be utilised, from all possible sources.
- Through content filtering and predictive analytics, student specific information will be generated, which will then be used to formulate a more personalised recommendation for a student.
- The Education Management Information System (EMIS) is a system responsible for gathering, capturing and storing the education data in each province.
- The data collected by the EIMS is from various educational sectors, such as Ordinary Schools, Early Childhood Development, and Further Education and Training institutions, Adult Education and Training and Inclusive Education.



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The effect of introducing interactive and collaborative social learning into online learning on participation and completion

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University of Limpopo

Introduction

South African Bill of Rights states that everyone has a right to basic education, including basic adult education and to further their education (South African Government, 1996). This right must be made progressively available and accessible by the state. The socio-economic dynamics of South Africa make it difficult for some who cannot afford fees for post matric education.

Massive open online courses (MOOC's) offer an opportunity to anyone who wishes to improve their knowledge due to its scalability. South Africa has high level of unemployment and the youth is the most affected. Some of the challenges arise from structural unemployment, in particular those who dropped out of school due to various reasons.

The challenge though in MOOCs is the high attrition rate. In a study by Bartolome and Steffens (2015) less than ten percent of student participating in MOOCs complete their course. This finding is also supported by another study (Africa, Garrido, Koepke, Andersen, & Garrido, 2016) which reported a high dropout rate among MOOC's participants, reporting a below 13%completion rate. One of the most interesting findings of the study undertaken by Africa et al. (2016) is that more than 80% of those enrolled are from low to middle class backgrounds, with basic to intermediate ICT literacy.

Research question

Two questions drive this study

1. What is the impact of interactive and collaborative social learning environment on online learning?
2. How effective is the introduction of interactive and collaborative social learning environment on participation and completion rate?

Research method

My research study aims to explore the effects of introducing interactive and collaborative social learning into an online learning environment on participation and completion rate. Social constructivism is the theory of people constantly learning and include interaction with others (Vygotsky, 1978). Figure 1 below demonstrates the use of social networks entwined with LMS.

As part of the learning goal setting, as theory of motivation, it will be used to encourage collaborative and social learning. Edwin Locke's theory as illustrated on Figure 2, states that specific and challenging goals lead to better performance. On line learning, which is mostly by individual's choice is driven by a certain goal and that serves as a motivation to achieve it. Figure 3 displays projected upward improvement in both participation and completion rate of students with a blended approach of goal driven interactive and collaborative social learning.

Research methodology and study design includes both controlled and uncontrolled groups, before and after the intervention. Use of Social Network Analysis (SNA) for data collection, monitoring, intervention, analysis and interpretation.

Figure #1

Figure #2

Figure #3

Results

On line learning students who are goal driven and receive the necessary support, through interactive and collaborative social learning are more likely to complete their courses. The predictive results are the increase in participation and completion rate on MOOC's participants. The positive feedback can serve as a motivation to others who may also want to upskill themselves.

Conclusions

Massive open online courses offer a great chance to those who need to prepare themselves with the skills required for the economic challenges of the current generation, especially technology. Academics need to continue to develop interventions to help improve and promote lifelong learning, more particular in the informal education. This study aims to contribute to a body of work that has already been pioneered by scholars.

References

Africa, S., Garrido, M., Koepke, L., Andersen, S., & Garrido, M. (2016). The Advancing MOOCs for Development Initiative An examination of MOOC usage for professional. *Seattle: Technology & Social Change Group, University of Washington Information School*.
Croxton, R. (2014). The role of interactivity in student satisfaction and persistence in online learning. *Journal of Online Learning and Teaching*.
Ferschke, O., Yang, D., Tomar, G., & Rosé, C. P. (2015). Positive impact of collaborative chat participation in an edX MOOC. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*.
Freire, P. (1993). Pedagogy of the Oppressed. 1970. In *Reprint, New York: Continuum*.
Huss, J. A., Eastep, S., & Sella, O. (2015). A case study of online instructors and their quest for greater interactivity in their courses: Overcoming the distance in distance education. *Australian Journal of Teacher Education*. https://doi.org/10.14221/ajte.2015v40n4.5
Keenan, I. D., Slater, J. D., & Matthan, J. (2018). Social media: Insights for medical education from instructor perceptions and usage. *MedEdPublish*. https://doi.org/10.15694/mep.2018.0000027.1
Krasny, M. E., Dubois, B., Adamett, M., Attoghe, R., Alfakihuddin, M. L. B., Held-Erdene, T., ... Yao, Y. (2018). Small groups in a social learning mooc (Slmooc): Strategies for fostering learning and knowledge creation. *Online Learning Journal*, *22*(2), 119–140.
https://doi.org/10.24059/olj.v22i2.1339
Nadkarni, A., & Hofmann, S. G. (2012). Why do people use facebook? *Personality and Individual Differences*.
https://doi.org/10.1016/j.paid.2011.11.007
Ristopovic, M., Cvetanovic, S., Medan, I., & Ljubojevic, D. (2017). The effects of integrating social learning environment with online learning. *International Review of Research in Open and Distance Learning*.
https://doi.org/10.19173/irrodl.v18i1.2645
South African Government. (1996). Constitution of the Republic of South Africa, 1996 - Chapter 2: Bill of Rights. *Constitution of the Republic of South Africa*. https://doi.org/10.1159/000144207
Wu, B., & Chen, X. (2017). Continuance intention to use MOOCs: Integrating the technology acceptance model (TAM) and task technology fit (TTF) model. *Computers in Human Behavior*.
https://doi.org/10.1016/j.chb.2016.10.028

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Gamification for Collaborative Learning in Information Systems Education

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Introduction

Gamification employs game elements such as points, badges and ranking systems to create an enticing experience (Landers, 2014). Diverse fields, including education, marketing and health are gamified. Virtually any activity or context in an organisation can be gamified. Gamification, however, beyond rewards. In Information Systems education, and education in general, it is suggested that gamification's value lies in the following capabilities (Landers, 2014):

- It has the potential to instil the concept that the players can fail in a task and replay it without serious risk ;
- it stimulates feelings of achievement and game immersion to keep players engrossed in an learning task;
- Promotes a sense of connectedness with team members while competing (against other teams) ; and
- Gamification is flexible in providing rapid feedback for measuring player competency .

Research Problem

Gamification presents challenges, which stems from dualistic ontological positions. Here, games and students are considered two separate, closed systems. This is a misconstrued behaviouristic approach (Vermeulen et al., 2016). For example, students at the top of a leaderboard following a gamified ICT learning task may feel a sense of accomplishment. However, leaderboards can also be harmful insofar as students, who are at the bottom of a leaderboard, becomes demotivated. Their poor performance is likely interwoven with the socio-cultural background e.g. limited or no exposure to ICT education reflects in the poor gameplay performance. Games, thus, is context-specific.

Methodology

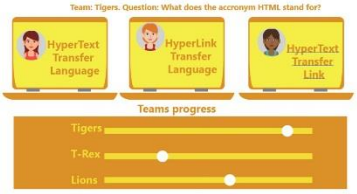
Instead of imposing gamification on students, the researcher believes that students should collaborate on the planning and implementation of the gamification strategy. The research candidate further follows a dialectical approach, as opposed to a dualistic approach. Here, gamification and games are viewed as the same and the value of game elements (e.g. leaderboards) depend on the meaning and value players assign to them. Also, the benefit of collaboration is that students can voice their desires and concerns to introduce meaningful gamified ICT learning (Vermeulen et al., 2016). This research study, therefore, adopts the transdisciplinary action research strategy. The action research model is characterised by a collaborative "iterative cycle of plan-act-reflect" (shown as an inset of Figure #1) (Oates, 2005, p. 172).

Figure #1

Diagnosis	Explain the purpose of Gamification
Planning	Jointly choose a gameplay strategy that aligns with learning goals
Intervention	Engage gameplay
Evaluation	Assess whether the game resulted in a more engage and motivating learning experience by conducting interviews and focus groups
Reflection	The transdisciplinary team deliberates on accomplishments of both new theories and outcomes

The students, in teams of three, played game called QUIZLET LIVE (2019). Quizlet Live can be played on a desktop PC or mobile device. QUIZLET allows educators to create educational questions from a specific field of study and present these questions to students. This study focuses on Programming and Communication, two modules of the Information Systems course under inquiry. In QUIZLET LIVE, team members on their respective devices are presented with the same question, but only one member of the team has the correct answer. Students need to work together to determine which member have the correct answer. Meanwhile, the competition between the teams is projected as a race over a data projector screen where teams can monitor their progress against other teams (cf. Figure #2).

Figure #2



Results

- Students showed appreciation for being given agency, i.e., their inclusion as decision-makers.
- Students with low IT self-efficacy criticized lack of agency imposed by the game system. To elaborate, if the team answers a question wrong, the game resets their progress; hence, they need to start from the beginning. If they could have changed the game, wrong answers should only move the team's progress one back. Conversely, students with strong IT-self-efficacy supported a complete reset of a team progress. They argue the complete reset motivate you to think carefully about the possible correct answer and not only guess the answer, thereby hoping that you will be lucky. Learning Motivation, therefore, is affected by this feature.
- Students with low IT self-efficacy the game's feedback and the 'try again' feature. It functions as follow: If a team answers a question incorrectly, the game navigates to a separate screen to indicate their answer is incorrect while also providing the correct answer. The question then reappears later in the game thereby giving teams the opportunity to attempt the questions again. Students with low IT self-efficacy feels that incorrect answers should be addressed on completion of the game; students with strong IT self-efficacy praises this feature, they argue it is good to succeed where you failed. Again learning motivation is affected by this feature.
- Agency presented problems insofar as students who were given the choice to decide chosen team members. Students who were had low ICT literacy skills expressed unhappiness at exclusion from strong teams (lowers self-efficacy). In contrast, they mentioned that participating in a team with members who had strong ICT skills were motivating towards ICT learning and raise self-efficacy.

Conclusion

This research project illustrated how vital a participatory methodology, such as action research is to determine the dynamics of collaboration is toward sound teamwork. Infusing such a methodology with fun activities such as gamification shows excellent promise for bridging relationships between people from different socio-cultural backgrounds. In the scope of this study, socio-cultural backgrounds, inter alia, denotes different ICT cultures i.e. low ICT skills and strong ICT skills liked to prior learning backgrounds. In the second cycle, acculturation has been incorporated to promotes social connectivity – the research candidate is in the process of analysing the data.

Bibliography

1. **Landers RN (2014). Developing a Theory of Gamified Learning: Linking Serious Games and Gamification of Learning. Simulation & Gaming, 45(6):752–768. (http://0-journals.sagepub.com.oasis.unisa.ac.za/doi/pdf/10.1177/1046878114563660, accessed 5 February 2018).**
2. **Oates BJ (2005). Researching Information Systems and Computing. London, Sage.**
3. **Quizlet (2019). Introducing our first collaborative learning game for the classroom: Quizlet Live [web site]. (https://quizlet.com/blog/introducing-our-first-collaborative-learning-game-for-the-classroom-quizlet-live, accessed 26 August 2019).**
4. **Vermeulen H, Gain J, Marais P, O'Donovan S (2016). Reimagining Gamification Through the Lens of Activity Theory. 5-8 January 2016. Koloa, Hawaii, USA. ACM Digital Library.**

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DIGITAL AGRICULTURE: THE PATHWAY TO SUSTAINABLE AGRICULTURE

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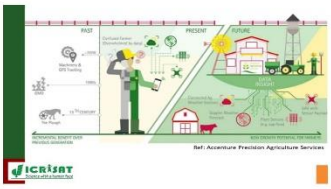
Introduction

South African farmers and those across the world have a challenge to deliver sufficient food to satisfy the expanding needs of food (Santos, 2006). In as much as they work hard to deliver, they experience production reductions, efficiency lessens, and thus food security is compromised. Farmers endure issues of satisfying market demands, while dealing with a number of challenges during the production cycle (Masoumch et al 2014). The issues farmers deal with on a day to day basis amongst other involve: water scarcity, prevalence of pests and diseases, high infestation of weeds, application of fertilizers to either known or unknown soil nutrient status as well a climate change (Van ES and Woodard 2016). However, Trendov et al (2019) suggests that digital agriculture as well as digital innovations might be part of the solution for farmers across the world. According to Webber et al (2017) digital agriculture aims to revitalise and to help achieve the objectives of the three traditional pillars of agriculture, namely: economic viability, environmentally friendly and socially acceptable. Digital agriculture does not only assist farmers to mitigate the overwhelming effects of climate change but also assist them to adapt and thrive in the Fourth Industrial Revolution (4IR).



According to Trendov et al (2019) digital agriculture refers to the tools with which farmers (smallholder or commercial) use to collect, store, analyze and electronically share data within the agricultural value chain. Furthermore, digital agriculture will help improve the smallholder farmers' access to information. Baumüller (2015) argues that technological innovations and mobile phones help farmers to have access to information related to: farming inputs, market, prices, training as well as funding. Therefore, digital agriculture stand a chance to improve efficiency in the farming industry as well as improve sustainability. However, smallholder farmers have the responsibility or rather, a role to play, which is to adopt the technological innovations such as digital agriculture and artificial intelligence so to improve their productivity.

Objectives

The objectives of the study are:
1. To determine the role of digital agriculture in agricultural productivity.
2. To examine factors affecting smallholder farmers' adoption of digital agriculture.

Methodology

The study reviewed literature relevant to the study theme and objectives. Furthermore, journals, books, and government reports (DAFF) were reviewed. The review of literature concentrated precisely on research findings available, relevant to the role of digital agriculture in ensuring sustainable agriculture.

Results

This paper defines digital agriculture, the role of digital agriculture in ensuring sustainable agriculture and also examines the factors influencing the adoption of digital agriculture by smallholder farmers. The discussion of the results is based on the study's delineated objectives.

Definition of digital agriculture as well as its role in the agricultural sector

Digital agriculture is the ecosystem of data and ICT, aimed at supporting the rapid development as well as the delivery of timely, targeted information and services so to ensure farming profitability and sustainability while delivering high nutritious but affordable food for all (ICRISAT 2016). However, Van ES and Woodard (2016) defines digital agriculture as the employment of computational and information technologies to improve the profitability and sustainability of agriculture. Furthermore, Digital Agriculture (DA) involves the use of advanced technologies (also used in Precision Agriculture), ICT as well as data available digitally, aiming to support farming by means of services such as the supply of climate related information, agricultural advisory services (on farm – self-service), sap flow and soil fertilizer recommendation.

Pillars of digital agriculture

There are several pillars of digital agriculture. However, this paper explores only two, namely: the basic minimum requirements of digital agriculture (DA) and basic enablers of DA. Basic minimum requirements of DA refers to the minimum conditions required to use the technology and it involves: availability, connectivity, affordability, ICT in education, policies and supporting programmes, the ICT infrastructure, educational attainment (level), computer literacy as well as accessibility (Trendov et al 2019). Basic enablers of DA refers to the factors which facilitates the adoption of the innovations and technologies.

Digital Agriculture Tools (DATs)

There are number of tools or technologies that enable digital agriculture for both crop and animal production. The DATs are many and different, serving different purposes, which is to either access or disseminate real time information with ease (Van ES and Woodard 2016). This include but not limited to: sensors, controllers, computational decision making tools, geo-locationing and communication, yield monitors, precise soil sampling, Unmanned Aerial Vehicles (UAVs), variable rate technologies, robotics, auto steer, automatic milking system, automatic feeding system as well as (RFI) Radio Frequency Identification (Trendov et al 2019 and Lou 2013).

The role of Digital Agriculture (DA) in the agricultural sector

Historically, a number of revolutions happened in the agricultural sector. All the previous revolutions were aimed to enhance efficiency, yields, and profitability (Trendov et al 2019). However, the expected outcomes were not achieved.

Hence, the market forecast suggests that the DA Revolution (DAR) will satisfy the aims of the agricultural sector by best responding well to the current agricultural issues (Webber et al 2017). DA will play a huge role in the agricultural sector to improve efficiency, yields and profitability. Moreover, DA's strength is on the fact that it will deliver to the Sustainable Development Goals (SDG) so to ensure sustainable agriculture (Trendov et al 2019). The table 1 illustrates how the three (3) traditional pillars of Sustainable Development will be achieved.

Pillars of sustainable development	Role of DA in achieving the SDGs
Economic viability	• Increased agricultural productivity • Cost efficiency • Market opportunities
Socially and cultural benefits (acceptability)	• Increased levels and channels of communication • Inclusivity (extension workers, researchers, farmers, marketing agents and financial institutions) • Timeliness • Improved employment opportunities
Environmentally friendly (benefits)	• Optimised usage of resources • Adaptation to climate change

Source: Sithole (11 December 2019)

It is therefore, satisfying to the objective of the study that is to determine the role of digital agriculture in the productivity of the agricultural sector across the world.

Factors influencing smallholder farmers' adoption of digital agriculture

All useful resources and inventions as well as technologies and innovations are to be adopted by users (Trendov et al 2019). However, there are known factors influencing the adoption of such technologies and innovations. Therefore, there are factors influencing the adoption of DA include but not limited to: IT infrastructure and networks in the rural areas, educational attainment, skills and digital literacy, policies and programmes for enabling digital agriculture, financial resources, agricultural stakeholders' social media preferences, the benefits of DA, timely information access as well as climate change effects (ICRISAT 2016 and Trendov et al 2019).

Conclusion

Digital agriculture is the pathway to sustainable agriculture in the world. Furthermore, DA is essential because it helps to improve productivity, efficiency, yields as well as profitability in the agricultural sector. Findings revealed that DA have pillars, namely: the basic minimum requirements of DA and basic enablers of DA. Moreover, DATs used in the DA inventions involves the automatic feeding and milking system, the Unmanned Aerial Vehicle (UAV), yield monitors, sensors as well as GIS. The major role of DA in agricultural productivity is evident in terms of agricultural efficiency improvement, enhanced yields, improved productivity, lowered production costs and improved employment. The factors influencing the adoption of DA have been revealed by the study to be level of education, digital literacy and skills, financial resources, availability and accessibility of IT technologies, social media preferences, climate change effects as well as the policies and programmes for enabling DA.

It is therefore, recommended that further studies be made to examine the effectiveness of the DA in the more practical way than on paper. Studies to evaluate the adoption of DA and its tools in the agricultural sector be conducted. Financial implications of the use of DA and DATs have not been examined, therefore, it is recommended that studies to explore such areas be conducted.

Bibliography

TRENDOV, N.M., VARAS, S & ZENG, M. 2019. Digital Technologies in Agriculture and Rural Areas. Briefing Paper. FAO, UN, Rome.

WEBBER, B.O, SALAMA, B, BARROS, F AND HELF, J.A., 2017, Digital Agriculture: Improving Profitability.

VAN ES, H & WOODARD, J. 2016. Digital Agriculture: Report and Recommendations. New York.

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Re-skilling South African Coal Miners in the Digital Era

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Introduction

The Fourth Industrial Revolution (4IR) has featured prominently in scholarly spaces and the South African media. Conversations are centred on how this new revolution will impact the lives of citizens in terms of work and their participation in the global economy. Equally, other countries and global organisations have similar concerns. This paper aims to explore the impact of digitalisation or the 4IR on the South African mining sector particularly concerning the future of work in this sector. The emphasis is drawn to the mining sector because evidence suggests that it contributes significantly to the employment of low-skilled workers in South Africa workers (Statistics South Africa, 2013:4). The study draws a focus on the coal mining industry because it is an extensively mechanised industry which has increased its upgrades in its use of technology in an attempt to extend the life of major coal deposits (Coal Mining Council South Africa, 2019). Therefore, the impact of digitalisation in this sector will be a signifier for future labour trends and the labour market.

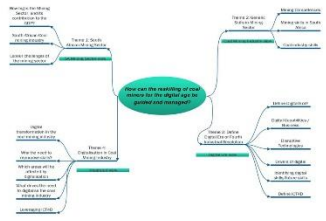
A clear challenge presented by the mechanisation and modernisation of mines is that Information and Communication Technology (ICT) is changing the nature of work, making human involvement obsolete in the digital era. The anticipated result of this is a consistent decline in the need of specific skills and jobs. In light of the urgency to curb job insecurity, a central part of this study seeks to understand how people in the coal mining industry "reskill" themselves to remain relevant and productive. This standpoint is also linked to how they transition towards possessing new skills in the digital era. The transformation introduced by ICT is not a fundamental drawback. However, a dominant challenge exists because of the deficiency in critical frameworks and methods that guide re-skilling processes for miners to acquire new skill sets. The study is situated within a broader debate on the implications of technological change on the nature of work and aims to develop a framework that will support the re-skilling and repurposing of current skills possessed by coal mine workers in the digital era.

The main research question for this study is: How can the reskilling of coal miners for the digital age be guided and managed?

The understanding is that mining companies will adopt disruptive technologies as indicated by several authors (Abrahamsson & Johansson, 2008; Coal Mining Council South Africa, 2019), The reason for this is that mining businesses would like to remain profitable in an industry that has seen a rapid decline over the past decade (Leeuw & Mtegha, 2018). There is a consistent agreement that jobs will be displaced or lost (Valsamis et al., 2015; Hirsch-Kreinsen, 2016; Gumede, 2018), particularly in the low-level skills category (Leeuw & Mtegha, 2018). Further to this, (Moavenzadeh, 2015; Balkaran, 2016; World Economic Forum, 2017; Lööw, Abrahamsson & Johansson, 2019) it is predicted that with every revolution, new jobs or skills are created. Oshokoya & Tetteh, (2018) suggests that future mining will depend on highly skilled skeleton labour force, with the ability to multitask through mechanised and remote-controlled operations and monitoring.

The key themes that will be explored by this research are shown in figure 1 below.

Figure #1



Methods

This study will utilise the qualitative research approach and plans to explore the digitalisation and skills development in the South African Coal mines. As such, the research will use the DSR methodology. Literature on DSR, indicates that there exists uncertainty about DSR as a research methodology. It does not appear in the list of methodologies mentioned by Oates (2006), Myers (2013) or Saunders (2007). Van Staden (2017) refers to DSR as a methodology and combines it with a case study as part of the methodology selection. The benefit of using DSR is its iterative research and design process which is suitable to develop and evaluate a framework or model as an artefact (Bärenfänger & Otto, 2015).

To develop this study, a full-text search on the following themes was conducted (see figure 2) using the search strings. The main themes identified are: future technologies (Digital era or Fourth industrial revolution (4IR)), digital skills or competency, mining skills, mining digitalisation (mechanisation) and future mining skills Figure 1

Figure #2

Results

Digital disruptions are a reality that is transforming how business is conducted while introducing new business models that did not exist in the past (Segal, 2016). These disruptions cut across all industries without exception (Segal, 2016).

Below is a list of reasons for digitalising the mines according to (O'Callaghan, 2017; Gumede, 2018):

- Safety of the employees;
- Improved operations to realise the benefits of real-time intelligence, safe working environment and effective communication.
- improved monitoring and supervision.
- Upskill employees;
- To run a sustainable mining operation

"The industry is expected to be knowledge-driven through a database model that receives and sends information (environmental, mining production and mineral processing) to enable proactive decisions to be made from both operational and control room perspectives" (Oshokoya & Tetteh, 2018).

Conclusions

The literature review provides a clear overview of the role that the South African mining sector, and the coal mining sector, in particular play in terms of labour towards the economy of the country and its growth. The SA mining sector experiences several challenges with safety, falling commodity prices, labour issues and policy uncertainties being the most prominently stated. By embracing digital technologies and developing a digital strategy, coal mining companies can leverage the benefits. The research needs to go into depth and identify the impacted capabilities and the skill sets that need to be repurposed. This will ultimately lead to the development of the ICT4D 2.0 learning process to advance displaced skills.

Recommendation

The topic of the 4IR is still relatively new however, based on the literature it has gained significant importance. The research question needs to be explored as the literature did not address the gap between the current minor position and the future minor position. The article by Lööw, Abrahamsson & Johansson, (2019) Introduces the base to start this work.

Bibliography

1. Abrahamsson, L. & Johansson, J. 2008. Future Mining - Workers' Skills, Identity and Gender When Meeting Changing Technology. In FIRST INTERNATIONAL FUTURE MINING CONFERENCE AND EXHIBITION 2008, PROCEEDINGS. 213–220. Available: http://www.diva-portal.org/smash/record.jsf?pid=diva2:1006456 [2019, June 11].
2. Bärenfänger, R. & Otto, B. 2015. Proposing a Capability Perspective on Digital Business Models. Proceedings - 17th IEEE Conference on Business Informatics, CBI 2015. 1:17–25. DOI: 10.1109/CBI.2015.18.
3. Balkaran, S. 2016. The Fourth Industrial Revolution - Its Impact on the South African Public Sector. Available: https://www.academia.edu/22826511/THE_FOURTH_INDUSTRIAL_REVOLUTION_-_ITS_IMPACT_ON_THE_SOUTH_AFRICAN_PUBLIC_SECTOR.
4. Coal Mining Council South Africa, M. 2019. Coal mining matters. Available: http://www.coalminingmatters.co.za/what-matters/technology [2019, June 19].
5. Gumede, H. 2018. The socio-economic effects of mechanising and / or modernising hard rock mines in South Africa. South African Journal of Economic and Management Sciences. 21(1):1–11. Available: https://doi.org/10.4102/sajems.v21i1.1848.
6. Hirsch-Kreinsen, H. 2016. Digitization of industrial work: development paths and prospects. Journal for Labour Market Research. 49(1):1–14. DOI: 10.1007/s12651-016-0200-6.
7. Leeuw, P. & Mtegha, H. 2018. The significance of mining backward and forward linkages in reskilling redundant mine workers in South Africa. Resources Policy. 56:31–37. DOI: 10.1016/j.resourpol.2018.02.004.
8. Lööw, J., Abrahamsson, L. & Johansson, J. 2019. Mining 4.0—the Impact of New Technology from a Work Place Perspective. Mining, Metallurgy & Exploration. 36(4):701–707. DOI: 10.1007/s42461-019-00104-9.
9. Moavenzadeh, J. 2015. The 4th Industrial Revolution: Reshaping the Future of Production. DHL Global Engineering & Manufacturing Summit. 57.
10. Valsamis, D., de Coen, A., Vanoeteren, V. & Van der Beken, W. 2015. Summary for Policymakers. In Climate Change 2013 - The Physical Science Basis. V. 1. Intergovernmental Panel on Climate Change, Ed. Cambridge: Cambridge University Press. 1–30. DOI: 10.1017/CBO9781107415324.004.
11. World Economic Forum. 2017. Realizing human potential in the fourth industrial revolution: An agenda for leaders to shape the future of education, gender and work. World Economic Forum White Paper. (July):22. Available: http://www3.weforum.org/docs/WEF_EGW_Whitepaper.pdf.

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