# INTERNET OF THINGS READINESS MODEL FOR HIGHER LEARNING INSTITUTIONS IN KENYA

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy

School of Computing
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DECEMBER 2021

## DEDICATION

Dedicated to my beloved father Chweya, mother Agnes, brothers Bob and Laban, sister's in-law, nephews Reagan, Emmanuel, Dylan, and niece Liana. Thank you for your love, support, and understanding.

## ACKNOWLEDGEMENT

I would like to thank God for allowing me to undertake my studies far from home. Moreover, I thank **Associate Professor Dr. Othman Bin Ibrahim** for his continuous guidance, tireless efforts, encouragement, and patience regarding this study. I am indebted to his support until the completion of my thesis.

I immensely thank my employer Kisii University for allowing me to proceed for further studies. I extend my appreciation to Dr. Mehrbakhsh Nilashi, Dr. Fredrick Awuor, Dr. Evans Miriti, Dr. Mary Otieno, Dr. Clenise Owino, Professor Bernard Misigo, Professor Lewis Ngetu, Mr. Mulonsia, Mrs. Nancy Marika for being very resourceful during this journey. I also thank my beloved parents Mr. Yabesh Chweya and Mrs. Agnes Chweya, my siblings for their love, endless support, prayers and encouragement, and financial support throughout this long journey. Finally, I appreciate all my friends who advised and encouraged me to complete this journey.

## ABSTRACT

The Internet of Things (IoT) has been an effective tool in enhancing access to information in learning environments to assist Higher Learning Institutions (HLIs) in improving the quality of education. There have been many successful implementations of IoT in educational sectors in developed countries. However, an exploration of previous studies on the usage of IoT shows that only a few studies have investigated IoT readiness within developing countries. The increase in the number of students, lack of enough physical infrastructure, lack of equity, and low funding has led to poor quality of education in Kenya. Therefore, the objective of this research is to analyse factors influencing IoT readiness and to propose a readiness model for Higher Learning Institutions in Kenya. The model is developed through the Software-as-a-Service (SaaS), and Tripod Readiness and Technology Readiness Index (TRI) models. Thirteen hypotheses are employed for the proposed model to test the impact of the readiness factors on the implementation of IoT by HLIs. A survey is conducted to examine the influence of the identified readiness factors on the implementation of IoT. A total of 181 respondents from three top Information and Communications Technology (ICT) learning institutions participated in the study. The collected data is analysed using the Partial Least Squares (PLS) method based on Structural Equation Modelling (SEM) and the Importance Performance Matrix (IPMA) is used to extract critical IoT readiness factors. The outcomes show that Relative Advantage, Simplicity, Compatibility, Top Management Support, IT Infrastructure, Competitor Pressure, Optimism and Insecurity had an impact on the implementation of IoT by HLIs. However, Experienceability, Partner Pressure, and Discomfort had no impact on IoT readiness. The outcome of this research shows that TRI influences technological, organizational, and environmental readiness on IoT readiness and attitude towards IoT. Moreover, both organizational and people factors are significant for IoT readiness in HLIs. The study offers an instrument and an IoT Readiness Model for implementing IoT in Kenyan HLIs.

# ABSTRAK

Internet Pelbagai Benda (IoT) telah menjadi alat yang berkesan dalam meningkatkan akses kepada maklumat dalam persekitaran pembelajaran untuk membantu Institusi Pengajian Tinggi (IPT) dalam meningkatkan kualiti pendidikan. Terdapat banyak pelaksanaan IoT yang telah berjaya dalam sektor pendidikan di negara maju. Walau bagaimanapun, penerokaan kajian terdahulu mengenai penggunaan IoT menunjukkan bahawa hanya beberapa kajian telah mengkaji kesediaan IoT dalam negara membangun. Peningkatan bilangan pelajar, kekurangan infrastruktur fizikal yang mencukupi, kekurangan ekuiti, dan dana pembiayaan yang rendah telah menyebabkan kualiti pendidikan yang rendah di Kenya. Oleh itu, objektif penyelidikan ini adalah untuk menganalisis faktor-faktor yang mempengaruhi kesediaan IoT dan untuk mencadangkan model kesediaan bagi IPT di Kenya. Model ini dibangunkan melalui model Perisian sebagai Perkhidmatan (SaaS), dan Indeks Kesediaan Tripod dan Teknologi (TRI). Tiga belas hipotesis digunakan untuk model yang dicadangkan untuk menguji kesan faktor kesediaan terhadap pelaksanaan IoT oleh IPT. Tinjauan juga telah dijalankan untuk mengkaji pengaruh faktor kesediaan yang dikenal pasti terhadap pelaksanaan IoT. Seramai 181 responden daripada tiga institusi pembelajaran Teknologi Maklumat dan Komunikasi (ICT) terkemuka telah mengambil bahagian dalam kajian ini. Data yang dikumpul dianalisis menggunakan kaedah Kuasa Dua Terkecil Separa (PLS) berdasarkan Pemodelan Persamaan Berstruktur (SEM) dan Matriks Prestasi Kepercayaan (IPMA) digunakan untuk mengekstrak faktor kesediaan IoT yang kritikal. Dapatan kajian menunjukkan bahawa kelebihan relatif, kesederhanaan, keserasian, sokongan pengurusan tertinggi, infrastruktur it, tekanan pesaing, optimisme dan ketidakpastian mempunyai kesan ke atas pelaksanaan IoT oleh IPT. Walau bagaimanapun, kebolehpengalaman, tekanan rakan kongsi dan ketidakselesaan tidak mempunyai kesan ke atas kesediaan IoT. Hasil penyelidikan ini menunjukkan bahawa TRI mempengaruhi kesediaan teknologi, organisasi dan persekitaran terhadap kesediaan IoT dan sikap terhadap IoT. Selain itu, kedua-dua faktor organisasi dan manusia adalah signifikan untuk kesediaan IoT di IPT. Kajian ini menawarkan instrumen dan Model Kesediaan IoT bagi melaksanakan IoT di IPT di Kenya.

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| | | |
|---|---|---|
| IoT | - | Internet of Things |
| HE | - | Higher Education |
| HEIs | - | Higher Education Institutions |
| HLIs | - | Higher Learning Institutions |
| ICT | - | Information Communication Technology |
| IoE | - | Internet of Everything |
| IPMA | - | Importance Performance Analysis |
| IT | - | Information Technology |
| KENET | - | Kenya Education Network trust |
| LMS | - | Learning Management Systems |
| M2M | - | Machine to Machine |
| MoEST | - | Ministry of Education Science and Technology |
| MOOCs | - | Massive Open Online Courses |
| NFC | - | Near Field Communication |
| PLS | - | Partial Least Squares |
| RFID | - | Radio Frequency Identification |
| RI | - | Readiness Index |
| SEM | - | Structural Equation Modeling |
| TAM | - | Technology Acceptance Model |
| TEL | - | Technology Enhanced Learning |
| TOE | - | Technology Organization Environment |
| TPB | - | Theory of Planned Behavior |
| TR | - | Technology Readiness |
| TRI | - | Technology Readiness Index |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Overview

Information and Communication Technology (ICT) is making a great impact in people's lives. Almost all innovations are based on ICT growth and changing the way people live, communicate, and perform different activities. Decades ago, the management of systems and institutions was different in comparison to what is happening due to the changes made by the ICTs and their growth capability. There has been much growth in technologies related to ICT like the Internet of Things (IoT) (Gubbi *et al.*, 2013), big data (Chen & Zhang, 2014), and cloud computing (Al-Fuqaha *et al.*, 2015; Raikar *et al.*, 2018). As an emerging technology, IoT has been predicted to grow at a rate of 20% Compound Annual Growth Rate (CAGR) from $1.9 trillion in 2013 to $7.1 trillion in 2020 (Abbasy & Quesada, 2017). This implies more than 20 to 50 billion connections by 2020 for the IoT solutions in the worldwide market. Notably, the growth market for sensory devices has been at 56.3 billion in 2010, 101.9 billion in 2015, and is expected to reach 190.6 billion by 2021 (Saarikko *et al.*, 2017; Sezer *et al.*, 2017).

Therefore, IoT can be defined as a dynamic worldwide system foundation that has the capability of self-configuration based on standards and interoperable protocols (Da Xu *et al*., 2014; Uzelac *et al*., 2015; Moreira *et al*., 2018). This entails the identification of physical and virtual things, physical attributes, and virtual personalities for intelligent interfaces by relying on the data network. IoT enables the devices to easily connect to the network without any limitation on time and location (Want *et al.*, 2015). According to Want *et al.* (2015), IoT can provide effective web service for meaningful data and accomplish activities through devices that are close to each other. IoT is allowing humans and things to have links without a specific path and service (Sezer *et al.*, 2017). IoT technologies include Radio Frequency

Identification (RFID), Wireless Sensor Networks (WSNs), middleware, and cloud computing (Atzori *et al.*, 2010; Lee & Lee, 2015).

It has been found that ICTs have great potential to upgrade the outcomes of teaching and learning (Mrabet & Moussa, 2017). This is because they can extend learning services to a wider geographical location (Lam *et al*., 2014). ICTs enable flexibility for learners, teaching staff, and institutions by considering time, location, and the teaching speed (Edwards & Bone, 2012; Ghislandi *et al.*, 2013; Lam *et al.*, 2014). Technology-Enhanced Learning (TEL) could be employed to satisfy the demands of the new knowledge society, enhance flexibility, and change the learning process (Aldowah *et al.*, 2017; Chen *et al.*, 2016; Zhu *et al.*, 2016). On the other hand, Electronic Learning (E-learning) is the facilitation of learning via electronic devices (Kasraie & Kasraie, 2010b). It facilitates the expansion of the scope and material for the curriculum. It also opens more enrolment spaces for higher learning institutions and colleges (Kasraie & Kasraie, 2010a). Massive Open Online Courses (MOOCs), virtual learning, and flipped classrooms are examples of eLearning platforms that can provide online learning to students.

However, IoT can effectively extend online teaching and learning to students with diverse processes (Moreira *et al*., 2018). It furnishes E-learning with intelligence and object integration in which things interact with every object and machines interact with machines (Abbasy & Quesada, 2017). It also allows active information transfer, in a self-directed way, leading to the growth of student skills. Previous research agrees that IoT can make people more knowledgeable about things such as being able to see virtual laboratories from a long distance (Roy *et al.*, 2016a). According to Atzori *et al.* (2017), IoT can provide vast opportunities for higher learning institutions. This includes bringing together independent control and the provision of better infrastructure robustness, scalability, and agility (Atzori *et al.*, 2017). The outcome can be the continuous communication of researchers between the real world and the digital world, provisioning the existence of physical objects into the digital world. Besides, new ways of employing real-time information that comes from the location of things are also created (Lamri *et al.*, 2014). Moreover, it can save the costs and help learners to take their classes at any time within university sites (Roy *et al.*, 2016b; Zhamanov

*et al.*, 2017). Therefore, IoT is expected to offer solutions that will alter the teaching and learning activity (Aldowah *et al.*, 2017; Da Xu *et al.*, 2014; Sezer *et al.*, 2017).

Based on the previous research agreement on the benefit of IoT in education (Abbasy & Quesada, 2017; Bagheri & Movahed, 2016; Banica *et al.*, 2017; Mershad & Wakim, 2018; Raikar *et al.*, 2018; Sezer *et al.*, 2017; Tan *et al.*, 2018; Zhamanov *et al.*, 2017), provision of learning online to students has altered the nature of education from traditional techniques to the sophisticated ones. IoT as a new actor in learning environments can play a significant role in bringing interactivity, improved learning, and understanding between instructors and learners, and virtual and physical objects within the learning environment (Marquez *et al.*, 2016). Thus, the potentiality of IoT in higher learning has gained popularity from different experts in higher education and industries (Majeed & Ali, 2018). There is now more focus on smart education (Zhu *et al.*, 2016) and the use of IoT technology to bring improvement to learners in a class (Tan *et al.*, 2018). Thus, with an increasing rate to utilize online teaching by higher learning institutions, assessment of readiness is becoming important among academics and researchers (Ancarani *et al.*, 2019; Isaias, 2018; Motala & Padayachee, 2018; Yahaya *et al.*, 2018).

Javahernia and Sunmola (2017) believe that readiness is a state of being prepared to ensure things are ready for development and implementation as planned. Assessing readiness aims to reduce the risk of failure and to bring out weak points that need improvement measures (Alshaher, 2013), at the initial stage of a project to escape later risks. In the case of IoT, before acceptance of this innovation in universities, consideration should therefore be given for the development of the plans by educators, politicians, and society (Moreira *et al.*, 2018). This is because readiness is more affected by what people trust, their attitude, and intentions (Bourrie *et al.*, 2015; Sabi *et al.*, 2016; Shin, 2014). Compatibility and perception of benefits are also important variables (Hsu & Yeh, 2016). Technological characteristics have proven significant when evaluating readiness (Atzori *et al.*, 2010; Bibri, 2015; Gao & Bai, 2014). Other researchers argue that individual perception is also a significant factor for readiness consideration (Bourrie *et al.*, 2015; Gao & Bai, 2014; Yee-Loong Chong *et al.*, 2015).

Studies (Hsu & Yeh, 2016) and (Peres *et al.*, 2018) believe that the environment factor is a significant measure for organizational readiness.

## 1.2 Background of the Problem

Integrating ICT into education is changing the education sector effectively (Albion *et al.*, 2015), with most changes resulting from emerging technologies and ICT (Uzelac *et al.*, 2015) like e-learning plans, virtual learning domains, and tele-education systems. ICT improves various sectors like medicine, education, and security (Banica *et al.*, 2017; Zhamanov *et al.*, 2017). These ICTs entail IoT, 3D printers, big data, and cloud computing (Al-Fuqaha *et al.*, 2015; Raikar *et al.*, 2018). IoT has been suggested to enhance teaching in learning beyond classrooms (Aldowah *et al.*, 2017; Roy *et al.*, 2016b; ur Rahman *et al.*, 2016). Hence, the education sector needs to advance the learning and teaching methods in the 21st century (Sarıtaş, 2015) to adapt to IoT, for a novel electronic teaching and learning platform (Abbasy & Quesada, 2017). In developed countries IoT has been developed and used. For instance, in the UK, Harlow UTC developed a collaboration between IoT and iCampus (Chin & Callaghan, 2013). The University of Wiscons in Madison has an IoT lab for enhancing learning (Majeed & Ali, 2018). However, developing countries like Kenya lack the implementation of IoT in their education systems.

In Kenya, the Ministry of Education, Science, and Technology (MoEST) strategic plan 2013-2017 requires the education sector to contribute, advance, and harmonize quality education, training, and research. From the interviews conducted, it was found that there is a lack of better infrastructure to reach more students in learning institutions in Kenya. Moreira *et al*. (2018) believe that both educators and decision-makers should enhance their awareness of current innovations to help them actualize the impact of IoT. Universities need to determine which technology tools best suit the provision of strong pedagogical practices to the technology-savvy population (Baker *et al.*, 2016). This will achieve the role of public universities in training human resources to attain the United Nations Millennium Development goals (Muchiri *et al.*, 2016). Therefore, to increase the number of learners and to maintain the utilization of

online learning services, educational institutions should increase their readiness to implement innovations (AjazMoharkan *et al.*, 2017; Motala & Padayachee, 2018; ur Rahman *et al.*, 2016). Readiness is a critical factor for the successful implementation of innovations (Wanless & Domitrovich, 2015). According to Motala and Padayachee (2018), technological, organizational, and environmental aspects together play an important part in the implementation of IoT. Some research has been carried out on IoT expressing the need for readiness from a technological viewpoint (Ancarani *et al.*, 2019; Bagheri & Movahed, 2016; Bibri, 2015; Motala & Padayachee, 2018), organizational context (Ancarani *et al.*, 2019; Elsaadany & Soliman, 2017; Motala & Padayachee, 2018) and environmental concern (Motala & Padayachee, 2018; Peres *et al.*, 2018). The mentioned elements positively enhance readiness to further remove organizational implementation issues (Al-Balushi *et al.*, 2014; Oster *et al.*, 2016). Apart from the above, people's context is mentioned as important in technology implementations (Moreira *et al*., 2018). For instance, a study by Shin (2014) posits that ICT is an essential element in people's everyday lives. While Bibri (2015) adds that it is necessary to genuinely understand what people need with new technologies and the benefits they expect to realize, to support interactions and actions.

Beliefs, attitudes, and intentions held by members of an organization portray organizational readiness regarding the extent of the changes (Bourrie *et al.*, 2015). Besides, it shows the capability of the organizations to successfully make those changes. Hence, critical to the success of IoT deployment are choices such as the social, cultural, and behavioral effects of how to develop, manage and evolve the IoT (Sabi *et al.*, 2016; Shin, 2014). The researchers add that these impacts on the outcome either successfully or lead to failure in the technology implementation process. However, research shows that IoT implementation in higher learning is still in premature stages (Abbasy & Quesada, 2017). The recent academic literature shows a gap in readiness for the implementation of IoT in developing countries. According to this study, there is limited research about IoT readiness in higher educational institutions in developing nations like Kenya. Besides, there is a gap in evaluating the effect of organizational and people contexts on readiness for implementation of IoT in universities both in developed and developing nations. As mentioned earlier, readiness can assist organizations to transform by eliminating obstacles (Al-Balushi *et al.*, 2014). Public universities in Kenya have made higher education the fastest-growing segment

(Macharia & Nyakwende, 2009), but offering online teaching and learning is not comprehensive.

According to Bandara and Ioras (2016) and Marquez *et al*. (2016), the role of online learning is attracting students to learning while improving their knowledge and skills. For example, The University of Nairobi is the leading public university in Kenya, yet it has not furnished any online learning through its website. The website is more of an information provider to visitors. Further, Kenya has experienced an increase in enrolment in HLIs (Odhiambo, 2016). The researcher's view is that this should necessitate Kenyan public institutions to shift their eLearning towards dynamic and collaborative ways. Interviews were conducted to establish the status of HLIs, and their preparedness to implement IoT. The outcome explains that the new generation learners as proactive, and more dependent on the internet for learning, and like to access information anywhere, anytime. The universities are currently using e-learning to support teaching and learning activities. Despite the lack of funding for better infrastructure, they have provided e-learning for most of the students. Furthermore, the universities have plans to extend physical classes to real-time for more accessibility.

There have been initiatives from the Kenyan government to support learning. For instance, the Government of Kenya has overseen the establishment of the Kenya Education Network Trust (KENET) (Tarus *et al.*, 2015). As per Tarus *et al.* (2015), the aim is to bring together all universities, tertiary, and research institutions through a manageable private network. Besides, it can save costs and improve sustainability with faster access to the global Internet. This is in line with the policy framework outlined in the Ministry of Education, Science, and Technology (MoEST) strategic plan 2013-2017 to consider education, training, and research with high quality. Also, the outcome is a society with knowledge, preserving justice, democracy, accountability, and inspires issue-based and results-oriented political engagements. This links education with the quality aspects which bring values for students by incorporating the ICTs in education (Chege, 2015).

One way to improve the quality of education is the implementation of IoT (Bagheri & Movahed, 2016; Marquez *et al.*, 2016; Roy *et al.*, 2016b). Hence, this research argues that IoTs can be employed in Kenyan higher education to utilize limited resources and smoothen the teaching process. Despite the above discussion, any online service has risks for clients like security, privacy, and hence E-learning activities are not exempted (Bagheri & Movahed, 2016; Lee *et al.*, 2017; Shaikh *et al.*, 2019). According to Isaias (2018), security and privacy difficulties have been critical issues in the deployment of emerging technologies. Hence, readiness can identify these weaknesses for further improvement and increase organizational readiness levels to treat these issues (Al-Balushi *et al.*, 2014). Readiness arises when there are no successful outcomes (Javahernia & Sunmola, 2017). Accordingly, a potential user needs to possess a certain level of readiness if they intend to use any new product or service (Thakur & Srivastava, 2014). Besides, readiness is a factor of individuals and organizations which is seen in the earlier phases of implementation (Wanless & Domitrovich, 2015). Equally important, readiness factors are characteristics helping organizations to solve hindrances, give capabilities for change, and reduce the risk of failure (Al-Balushi *et al.*, 2014; Javahernia & Sunmola, 2017). This brings the need for institutions to consider readiness if they have plans for implementation (Oster *et al.*, 2016). Accordingly, linking technological development with social development will lessen the chance of people rejecting new technologies and societal actors in misdirecting and misallocating resources (Bibri, 2015). This research hence concludes that without readiness, IoT implementation might be difficult.

On the other hand, students are also currently being driven by various motivations such as IoT to support their learning processes (Stewart *et al.*, 2017). This is because of fact that IoT is opening doors for learning alternatives to expand ubiquitous computing (Gonzalez *et al.*, 2008). The purpose of IoT is: guiding creative and innovative learners (Cheng & Liao, 2012; Domingo, 2012; Johnson *et al.*, 2015; Zhu *et al.*, 2016), improving knowledge, skills, and learner performance (Ali *et al.*, 2017; Chen & Huang, 2012; Coccoli *et al.*, 2014; Gómez *et al.*, 2013; Lamri *et al.*, 2014; Njeru *et al.*, 2017; Tan *et al.*, 2018; Yamada *et al.*, 2016), training critical thinker by making the learning environment intelligent (Domingo, 2012; Yamada *et al.*, 2016), improving a firm's competitive advantage (Li *et al.*, 2012; Miorandi *et al.*, 2012), cost saving for institutions (Bagheri & Movahed, 2016; Chen *et al.*, 2014; Petkovics &

Petkovics, 2014), gathering, storing data and control of devices hence ensuring information is shared across people and devices (Li *et al.*, 2012; Petkovics & Petkovics, 2014) and making available an ideal environment for accessibility of high-quality resources (Tan *et al.*, 2014). From the above discussion, this research posits that IoT can help in cutting costs required by the educational institutions and further improve educational systems.

According to Mershad and Wakim (2018), this can benefit the new institutions being set up for scalability. Moreover, it can allow easy partnership linking staff and students everywhere and anytime compared to the current campus-only access model in many establishments. IoT technology can transform education through processes (Mershad & Wakim, 2018; Njeru *et al.*, 2017). According to AjazMoharkan *et al*. (2017), it is believed that IoT technology can expand the overall intake of students and widen the geographical base. Also, Bagheri *et al*. (2015) and Petkovic *et al.* (2014) believe that it can increase universal efficiency for the institution and faculty members and provide anytime anywhere education. Besides, it can enable the students and staff to reach more learning resources, ease resource sharing, and overall expand the quality of teaching (Farhan *et al.*, 2017; Tan *et al.*, 2014). The usefulness of the incorporation of IoT is acknowledged as a key element for the economic and social development of a nation by both academicians and practitioners (Mital *et al.*, 2017). Therefore, this study aims to understand the readiness of HLIs in Kenya to implement IoT. Moreover, a readiness model is developed by considering organizational and human factors.

## 1.3 Problem Statement

The result of poor quality of education in higher education is caused by a lack of equity, low funding, and high enrolment numbers (Chege, 2015; Ndirangu & Udoto, 2011; Odhiambo, 2016). Accordingly, there are strong pressures all over the world on how to create a balance between the demands of quality, equity, and funding in enrolments in the face of fast expansion (Calvo *et al.*, 2010; Daniel, 2015; Schendel & McCowan, 2016). It is found that higher education is regularly searching for ways to increase the number of learners in a low-cost way (Daniel *et al.*, 2015). However,

research agrees that large classes affect the quality of education concerning the environment for learning (Hornsby & Osman, 2014; Loh Epri, 2016). In addressing the above issue, the Internet of Things (IoT) is recognized as a tool that can solve the occurrences of the related issues (AjazMoharkan *et al.*, 2017; Farhan *et al.*, 2017; Roy *et al.*, 2016b; Tan *et al.*, 2018).

According to Moreira *et al.* (2018), concerns such as lack of understanding that result in the preparedness of educators, politicians, and society are the major issues faced towards the implementation of IoT. Subsequently, there is a demand to evaluate and design how to handle these issues. Successful implementation of IoT depends upon understanding factors that increase the readiness of learning institutions. For instance, Yahaya *et al.* (2018) indicated that ICT Infrastructure results in organizational readiness. Hence concentrating on ICT infrastructure will improve lecturer satisfaction by improving their organizational readiness. Readiness entails a state of preparedness for something yet to occur (Javahernia & Sunmola, 2017). It is seen in the initial stages of implementation and brings out characteristics that assist organizations to transform through the elimination of obstacles (Al-Balushi *et al.*, 2014; Wanless & Domitrovich, 2015). According to Moreira *et al*. (2018), the most significant element in the implementation of IoT is understanding the readiness factors for educators and decision-makers. Few researchers have investigated readiness from the organizational context (Motala & Padayachee, 2018; Wielki, 2018). Bibri (2015) suggests that there is a need to also link technological development with social development to minimize the failure of new technologies and societal actors in misdirecting and misallocating resources (Bibri, 2015). Therefore, in this research, people's context is also considered along with other readiness factors. There are few theoretical models to understand readiness for implementation of the Internet of Things (IoT) in higher learning institutions. This brings out the key justification of this research to evaluate readiness for HLIs in Kenya to implement the Internet of Things.

To address the key issues of quality education, the main research question was: "How IoT can be implemented in Higher Learning Institutions in Kenya?" This brought out the following sub-questions:

i. What are the readiness factors influencing the Internet of Things (IoT) in Higher Learning Institutions (HLIs) in Kenya?
ii. What is the relationship between the factors on the readiness of HLIs in Kenya to implement IoT?
iii. How the readiness model can be developed for the implementation of IoT in HLIS in Kenya?

## 1.4 Research Objectives

The research objectives are explained based on the problem statement. The specific objectives of this research include:

i. To understand the readiness factors influencing the Internet of Things in Higher Learning Institutions (HLIs) in Kenya.
ii. To investigate the relationship between the factors on the readiness of HLIs in Kenya to implement IoT.
iii. To develop a readiness model for the implementation of IoT in HLIs in Kenya.

The first objective seeks to extract the key characteristics that have a significant effect on IoT in Kenyan HLIs. From the literature, this study extracted the relevant literature discussing the elements that play a role in readiness for IoT, more so with regards to organizational and people contexts. The elements were extracted, analyzed for suitability, and grouped into variables of technological, organizational, environmental, and people contexts. The second objective sought to establish the link between the extracted factors and IoT readiness; that is, how the extracted factors relate with IoT readiness, either negatively or positively. This was done by creating hypotheses and testing the relations. SEM was used with Smart PLS for validation. The third objective aims to design an IoT readiness model from the relevant factors. After the elimination of factors that are insignificant, the final model is then established. The model merges the TRI and SaaS Tripod Readiness model. The model may assist higher learning institutions to assess IoT readiness.

## 1.5 Scope of Research

The focus of this research was on the universities' readiness for implementation of IoT in Kenya. Therefore, the unit of analysis was the university ICT in-charge persons, and lecturers. The ICT in-charge persons are responsible for the implementation of IoT technology in the learning institutions. On the other hand, the lecturers are aware of the technology trends and the benefits and issues linked with IoT. Hence, they are better placed in imparting knowledge to students and are important in IoT implementation in HLIs. This research targeted Kenyan higher learning institutions that are using ICTs in Learning. The reason for choosing HLIs is because they create a link between better economic development, new research, and innovation when new technologies are implemented. Interviews were done with the ICT in-charge persons to understand the current readiness for the implementation of IoT in the selected universities. A survey employing online, and paper-based questionnaires was conducted. The testing of the data was done by Structural Equation Modelling (SEM) involving the Partial Least Squares (PLS) approach. SmartPLS 3.0 software was used for data analysis.

## 1.6 Significance of the Research

This study is significant in providing an understanding of the key elements influencing readiness for IoT in HLIs. Incorporating IoT in learning and teaching impacts institutions positively. For instructors to fulfil their mandate, there is need for new pedagogical tools to improve the learning environments. Nowadays, the new generation of learners prefers the Internet of Things (IoT) for learning purposes. This is because of the usefulness of IoT for high access speed and anywhere anytime learning. On the other hand, universities have limitations on budget and the number of technical staff which makes it necessary to use IoT in HLIs. IoT is progressively becoming widespread as a better way to provide low-cost internet learning solutions. However, the benefits of incorporating IoT into the learning activities are more dependent on its successful implementation in HLIs. The study will help the universities in Kenya to continue to evolve for the adoption of new technology and

external forces, new frameworks, new regulations, and optimization of internal solutions. The main motivation for this research is to provide a readiness model for HLIs in Kenya. This can illustrate better ways to measure the development and progress in new technologies. This also can enhance learning, teaching, and research. Readiness for IoT implementation may assist higher learning institutions in Kenya to know what to consider before incorporating IoT. This can later translate its vision and mission to evolve to the desired future state and achieve the objective of Information Technology (IT) alignment. It has been found that quality in teaching and learning has a significant role in attracting students to higher learning institutions.

This research brings more insights in understanding IoT in Kenyan university settings in the following ways. First, this study brings out the benefits of IoT for higher learning institutions. For IoT implementation to happen, HLIs need to understand the benefits of this technology. Second, by synthesizing and using SaaS Tripod Readiness Model and TRI as the research models in IoT implementation, this study brings about a contribution to the research theory. This theoretical model will facilitate decision makers of HLIs to gain an understanding of the significant elements for IoT adoption from the perspectives of organizational and people contexts. Furthermore, identifying the factors that influence IoT readiness and developing an instrument to guide on IoT readiness acts as a guideline for decision makers in IoT readiness. The factors are grouped into four categories: organizational, environmental, technological and people contexts.

The findings of this research contribute to the body of knowledge about better ways of implementing IoT in the educational systems of Kenyan universities. It may further support decision-makers in understanding the organization's position regarding IoT. Besides, this research tried to identify the main gaps that may hinder the implementation of IoT. The assessment may help identify organizational strengths that can be used to support IoT initiatives. Understanding the key factors that influence IoT may help the Ministry of Education and university decision-makers in Kenya to plan their strategies. This may provide support and encourage teaching staff to incorporate these technologies into their teaching and learning for a high quality of education. The research may also reshape the way the Kenyan higher learning institutions acquire and

use software, platforms, and infrastructure for competitive advantage. Above all, it presents avenues for continuing theoretical and empirical research investigations in the field of IS and learning systems. The research will further lend a hand to future researchers in this area by forming a basis for their research.

## 1.7 Summary

This chapter provided an overview of the research, the important role of IoT in HLIs, and the problems associated with the readiness for IoT in Kenyan HLIs. A discussion was made on the importance and gaps in the literature. According to the problem background and statement, the research questions along with the objectives were provided. The significance of this research on the use of IoT for HLIs and the contributions of the proposed model in the field of IoT are presented. The researcher also defined the scope of this research from different perspectives. Finally, the structure of this research is presented.

## 1.8 Structure of the Thesis

The thesis contains six chapters which are structured as follows:

Chapter 1 initiates the theme and the context of the research, including the research problem, objectives of the exploration, significance, scope, and structure of the thesis. This chapter presents an overall summary of the whole thesis.

Chapter 2 explores the past literature regarding the IoT, the new generation of learners, and the current situation of learning in Kenyan HLIs. The benefits of IoT in learning and the importance of developing a readiness model are also highlighted. It also highlights prior models in HLIs together with the factors related to the implementation of IoT in terms of organizational and human contexts. This chapter acts as an initiator for the development of the initial model from the literature.

Chapter 3 describes and justifies the design and methodology used in this study, where the positivist paradigm was applied. It also describes the operational framework that included several phases to achieve the objectives of this study. This chapter details the stages and procedures for research throughout the entire study.

Chapter 4 examines the questionnaire with its reflective and formative measurement models. It further discusses the pilot study results using SmartPLS which played an important role in questionnaire development for main data collection. This chapter helps in the establishment and validation of the instrument for data collection.

Chapter 5 explains the demographics of the questionnaire results. Descriptive analysis was used. The discussion on the analysis and development of the model is using SEM. Finally, hypothesis testing is explained. This chapter brings out the data results and the final model development.

Chapter 6 explores how the research objectives were achieved and the contribution of the research theoretically and practically. Further, limitations and recommendations for future research are provided. This chapter gives the outcomes of the whole study.

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