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Supporting Micro-learning Access through the Ujuzi Mobile App: A Brokerage Deployment Model and Pilot Study for Tanzanian Higher Education Institutions

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ABSTRACT

It is evident that the high proliferation of mobiles technologies in resource-constrained areas such as Sub-Saharan Africa is improving the wellbeing of the communities. Hailed for its allegiance, affordances as well as ubiquitous nature, mobiles (smartphones, tablets etc) have assumed the empowering and liberating roles to the powerless and the underprivileged communities. In fact, mobiles are seamlessly connecting communities to the global public spaces on the Internet. Hence, the underprivileged, as well as remote communities through their mobiles are able to participate in public debates, traverse the Internet nodes to communicate and access public learning resources.

The micro-learning approach represents the new development in education sectors. It is the learning approach that uses small learning units (chunks) also known as micro-learning units to deliver a learning experience to learners. Hailed for improving retention capacity, competition rate, flexibility, interactivity as well as cost-saving, micro-learning brings its own challenges related to access and deployment. Through the application of a combination of theoretical frames, namely the Design Science Research Approach, the Connectivism Learning Theory, and the Critical Theory of Technology (CTT), together with the educators, students, technologists and members of the management teams from UDOM, UDSM, OUT, and MU, it was possible not only to explore the situation of micro-learning access and deployability in the HEIs in Tanzania but also to devise solutions for the main challenge: it became evident that the introduction of brokerage services has the potential of improving the quality of micro-learning access. The Ujuzi (translated from Kiswahili language means skills, knowledge, and know-how, accessible at www.ujuzi.ac.tz) app implementation case at MU proposed a way of improving micro-learning access. The case has highlighted that brokerage services shorten time needed to search for and leads to quality and skills-based micro-learning content Also, in this dissertation, a micro-learning deployment model is proposed to guide future researchers as well as practitioners involved in the manifestation of micro-learning services.

Because micro-learning research is at the infancy stage, more research is needed to improve knowledge and practices. As the forecasts concerning mobiles suggest an exponential growth in the near future, we argue that it is high time for the educational stakeholders including the decision-makers to reconsider embracing integrating mobiles into education. If we are to rely on CTT then societies have to face the realities of usage and actually participate in shaping

how technologies are used. Rather than banning mobiles in an educational environment, the effort should be directed towards empowering learners in the best practices. Also, we show that an enabling environment needs to be created to identify, recognize and integrate micro-learning. Specifically, there is the need to create awareness, improve digital literacy, expand loans to students, and establish quality controls as well adopt an integrated policy approach so as to consolidate developments in all social sectors. Herein micro-credentials for skills-based learning play a key role.

ABSTRACT IN DUTCH

Het is duidelijk dat de grotere toepassing van mobiele technologieën in gebieden met beperkte hulpbronnen zoals Sub-Sahara Afrika het welzijn van de lokale gemeenschap kan verbeteren. Met kenmerken zoals betrouwbaarheid, betaalbaarheid en alomtegenwoordigheid, hebben mobiele telefoons (smartphones, tablets, enz.) een emanciperende en bevrijdende rol op zich genomen voor de kansarme lokale gemeenschap. In feite verbinden mobiele telefoons gemeenschappen naadloos met de wereldwijde openbare ruimte op het internet. Daarom kunnen kansarmen en afgelegen gemeenschappen via hun mobiele telefoons deelnemen aan het openbare debat, het internet exploreren om te communiceren en toegang te krijgen tot publiek beschikbare leermiddelen.

De benadering van micro-leren vertegenwoordigt een nieuwe ontwikkeling in het onderwijs. Het is de leerbenadering die kleine leereenheden (‘pakketjes’) gebruikt, ook wel micro-leereenheden genoemd, om een leerervaring aan te bieden. Door de betere retentiecapaciteit, het aanspreken van specifieke competenties, flexibiliteit, interactiviteit en kostenefficiëntie, heeft micro-learning nochtans ook zijn eigen uitdagingen met betrekking tot toegang en inzet. Door de toepassing van een combinatie van theoretische kaders, namelijk de Design Science Research Approach, de Connectivism Learning Theory en de Critical Theory of Technology (CTT), samen met de lesgevers, studenten, technologen en leden van de managementteams van UDOM, UDSM , OUT en MU, was het niet alleen mogelijk om de situatie van micro-learning toegang en inzetbaarheid in de hogeronderwijsinstellingen in Tanzania te verkennen, maar ook om oplossingen te bedenken voor de belangrijkste uitdaging: de introductie van bemiddelende makelaarsdiensten die potentieel de kwaliteit en toegang tot micro-leren verbeteren. De implementatie van de Ujuzi app (vertaald uit de Kiswahili-taal betekent dit ‘vaardigheden, kennis en knowhow’), toegankelijk via www.ujuzi.ac.tz, bij MU heeft een manier aangeboden om de toegang tot micro-leren te verbeteren. De casus heeft aangetoond dat zulke bemiddelende makelaarsdiensten de tijd verkorten die nodig is om te zoeken in het aanbod van kwaliteit en op vaardigheden gebaseerde inhoud voor micro-leren. Ook wordt in dit proefschrift een implementatiemodel voor micro-leren voorgesteld om toekomstige onderzoekers en praktijkmensen te begeleiden die betrokken zijn bij de manifestatie van diensten voor micro-leren.

Omdat micro-learning onderzoek zich in de kinderschoenen bevindt, is meer onderzoek nodig om kennis en werkwijzen te verbeteren. Omdat de voorspellingen met betrekking tot mobiele telefoons een exponentiële groei in de nabije toekomst suggereren, stellen we dat het de

hoogste tijd is voor de belanghebbenden in het onderwijs, inclusief de besluitvormers, om de integratie van mobiele telefoons in het onderwijs te overwegen. Als we op de CCT theorie mogen vertrouwen, moeten samenlevingen de realiteit van het gebruik onder ogen zien en daadwerkelijk meewerken aan het in de praktijk gebruiken van technologieën. In plaats van mobiele telefoons in een educatieve omgeving te verbieden, moet de inspanning worden gericht op een empowerment van leerlingen in een 'best practices' benadering. We laten ook zien dat een ondersteunende omgeving moet worden gecreëerd om micro-leren te identificeren, herkennen en integreren. Concreet is er de noodzaak om bewustwording te creëren, digitale geletterdheid te verbeteren en financiële leningen aan studenten uit te breiden en kwaliteitscontroles in te stellen in een geïntegreerde beleidsaanpak van consolidatie in alle sociale sectoren. Hierin spelen de zgn. 'micro-credentials' voor op vaardigheden gebaseerd leren een belangrijke rol.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

AT	Activity Theory
ByD	Bring your own Device
CIVE	College of Informatics and Virtual Education
CTT	Critical Theory of Technology
CVL	Center for Virtual Learning
DOI	Diffusion of Innovation
DSR	Design Science Research
DUCE	Dar es Salaam University College
EDUCAUSE	EDUCAUSE Center for Analysis and Research
GIFs	Graphics Interchange Format
GPS	Global Positioning System
HEIs	Higher Education Institutions
HESLB	Higher Education Student Loans Board
ICT	Information and Communication Technology
iOS	iPhone Operating Systems
IS	Information System
IT	Information Technology
KIUT	Kampala International University Tanzania
LANs	Local Area Networks
LMS	Learning Management Systems
MCL	Micro-Learning
MIT	Massachusetts Institute of Technology
MLU	Micro-Learning Unit
MoLENET	Mobile Learning Network
MOOCs	Massive Open Online Courses
MU	Mzumbe University
MUHAS	Muhimbili University of Health and Allied Sciences
NACTE	National Council for Technical Education
NM-AIST	Nelson Mandela African Institute of Science and Technology
NTP	Nuffic Tanzania Programme
OS	Operating Systems
OUT	Open University of Tanzania
PCs	Personal Computers
SA	South Africa

SUA	Sokoine University of Agriculture
TAM	Technology Acceptance Model
TCU	Tanzania Commission for Universities
THLE	Tanzania Higher Learning Education
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UDOM	University of Dodoma
UDSM	University of Dar es Salaam
UNDP	United Nations Development Programme
URL	Uniform Resource Locator
UTAUT	Unified Theory of Acceptance and Use of Technology
VETA	Vocational Education and Training Authority
Wi-Fi	Wireless Fidelity

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

There is no doubt that the advances in the area of information technology (IT) are continuously transforming our ways of doing things in all sectors of lives. In education, for example, the introduction of personal computers (PCs) and the Internet marked the birth of electronic learning (e-learning) over three decades ago. The introduction of e-learning combined with the commercialization of education forced various learning institutions across the globe to respond to the new vibe by deploying e-learning platforms as well as developing online and distance-based courses (Langenbach, 1998). The e-learning trend reached a peak when universities started offering massive open online courses (MOOCs) to the thousands of learners across the globe. Particularly, the MOOC course on artificial intelligence from Stanford University is highly referenced for attracting over 150,000 students from across the globe (Knox, 2014). Other projects include the EdX programme organized by the Harvard University in partnership with the Massachusetts Institute of Technology (MIT), which offers online learning to millions of people in the world (Mackness, Waite, Roberts, & Lovegrove, 2013).

Likewise, the high proliferation of the Internet, social media applications as well as mobile technologies powered by wireless networks and broadband technologies is reshaping socio-economic structures, affecting how we live, how we communicate, how we learn and conduct business. In particular, smartphones have become ubiquitous to our lives due to their flexibility, portability, affordability, ease-to-use and multi-functionality, so that it is forecasted that Africa will have 725 million unique subscribers in 2020, generating revenue of $210 billion (GSMA Intelligence, 2016). In fact, mobile penetration in Africa has topped access to electricity and safe-and-clean-water (Isaacs & UNESCO, 2012). People read more on smartphones than they do on printed texts, especially young generations. As Castells (2004) predicted, we are living in a network society, full stop.

Just like the PCs and e-learning innovations, the high proliferation of mobile technologies (mobiles) gave birth to mobile learning. As we are adjusting to accommodate mobile learning, a new learning approach emerges under the name of micro-learning. In this chapter, we introduce the four-year PhD research project conducted by the scholar by involving the respondents from the four universities in Tanzania, concerning: *Supporting Micro-learning*

Access through the Ujuzi Mobile App: A Brokerage Deployment Model and Pilot Study for Tanzanian Higher Education Institutions.

The chapter is organized as follows: Section 1.1 introduces the chapter. Then the background information is provided in section 1.2. Next, in section 1.3 we present our statement of the problem. Also, the focus and scope of the study are presented in section 1.4. Likewise, section 1.5 and 1.6 present the research objectives and questions respectively. In addition, the justifications of the study are presented in section 1.7. Finally, we present how the dissertation is organized in section 1.8.

1.2 Background Information

As introduced earlier, the high proliferation of mobiles gave birth to mobile learning (m-learning). Ailed for its allegiance, affordances as well as ubiquitous nature, mobiles have assumed the empowering and liberating roles to the powerless and the underprivileged communities. In fact, mobiles are seamlessly connecting communities to the global public spaces on the Internet. Hence, the underprivileged, as well as remote communities through their mobiles are able to participate in public debates, traverse the Internet nodes to communicate and access public learning resources. Moreover, mobiles allow learners to interact and perform learning activities regardless of location and time spaces. No wonder, Brown (2003) envisioned that Africa is more suited for mobile learning due to the infrastructural challenges.

Prompted by the high proliferation of the mobiles and mobile learning trend, researchers across the globe explore the phenomena as an attempt to identify the efficacy and ways in which society can leverage from the devices (Isaacs & UNESCO, 2012). In fact, various m-learning projects and researches of different magnitudes from across the globe to study the phenomena are initiated including the Mlearn project, funded by the European Commission to build pedagogical and technological capacity to teachers in four member countries (The United Kingdom, Netherlands, Greece, and Italy) on how to productively apply the handheld devices in their classrooms (Barker, Krull, & Mallinson, 2005). Unfortunately, the usability challenges of mobile phones, software compatibility issues as well as the lack of standards for deploying m-learning services, limited the majority of the projects from fully succeeding (Kukulska-Hulme, 2007).

Subsequently, the above challenges triggered the birth of yet another idea, the Micro-learning. Hence, micro-learning through the use of micro-units is intended to address the

usability challenges as well as the lack of concentration and retention capacity faced by modern learners. Specifically, it concerns with designing, developing and delivering contents and activities that not only satisfy learners' characteristics regardless of their proximity and vicinity but also to address the usability issues. It is proven that delivering contents in long learning sequences and large chunks limits the m-learning potentials; therefore micro-learning contents are organized into small units or "chunks", known as micro-units with a high degree of interactivity and feedback. It is proven that learning in "small chunks" combined with well-designed micro-activities and feedback improves retention capacity and efficiency as described in the coming sections (Kadhem, 2017).

1.2.1 Understanding Micro-Learning

Due to the fact that micro-learning is an emerging area of research, there is no concise definition approved by the general public. However, scholars agree on the three main attributes of micro-learning: the size of the content, the duration it takes to complete a learning micro-unit, and the scope of the content (Bruck, Motiwalla, & Foerster, 2012). In fact, it is widely accepted that micro-learning content is supposed to be simple and short to fit the size of mobiles, digestible and executable within a shorter duration to accommodate the modern learners (Kadhem, 2017). Also, the scope of the content should focus on simplicity and specificity; a single micro-unit addresses single learning objectives as well as focuses on a specific skill relevant to the learner (Sánchez-Alonso, Sicilia, García-Barriocanal, & Armas, 2006). Just to illustrate, a single e-learning or m-learning topic is broken into several micro-units ("chunks") in order to fit the above descriptions (Polasek & Javorcik, 2019).

Globally the micro-learning and micro-credential research and activities are continuing to shape the way learning can be organized and implemented within organizations and education institutions. Among the key success of the micro-learning research is the standardization of concept especially the provision of properties that distinguishes it from other approaches (Hug, 2005). Likewise, there exists a multitude of software platforms as well as application developed to manage and facilitate micro-learning offerings across the globe (Pappas, 2018). In addition, by the end of 2016, the there were more than 967,966 badges earned by the learners around the globe (Fong et al., 2016). In chapter 2 we provide a detailed account of key micro-learning applications and apps and their features. Unfortunately, apart from the visomo project, conducted in collaboration between VETA and Airtel Tanzania, little is known about micro-learning research and activities in Tanzania ("VETA," 2019).

Currently, micro-learning are being integrated in MOOCs by the prominent providers including the Coursera offered in collaboration with universities including Stanford University as well as Duke University (www.coursera.org) and the Future Learn offered in collaboration with universities including the University College of London (UCL), Leeds University, the European Institute of Innovation and Technology just to name a few (www.futurelearn.com). Other platforms including the Udemy (www.Udemy.com) offers a multitude of courses by using a micro-learning approach. In fact the researcher in order to gain experience with micro-learning approach, he enrolled and graduated in three micro-learning courses offered by the UCL and the Accenture through the future learn platform: Digital Skills: social media https://www.futurelearn.com/courses/digital-skills-social-media, Digital Skills: digital marketing https://www.futurelearn.com/courses/digital-skills-digital-marketing and Why we post https://www.futurelearn.com/courses/anthropology-social-media. The listed courses provide a snapshot of the growing micro-learning trend globally.

There are several motivations factors drawing organizations and educational institutions into micro-learning learning approach including the following: first, micro-learning is deemed a natural attraction for the new generation of learners as it applies the rule of social media and the Internet. Specifically, the new generation of learners is used to the social media platforms, including Twitter, Facebook, Instagram, YouTube etc. which use micro-contents. Because short instructions are easy to absorb and interact with, it improves the retention capacity (Kadhem, 2017). Also, micro-learning units fit well with the ubiquitous mobile devices (Smolle & Bruck, 2017). Second, s discussed in chapter 2, micro-learning is regarded as the desired approach in providing professional developments in several organizations because it fits with the characteristics of modern employees (Buchem & Hamelmann, 2010). Third, micro-learning is convenient in such a way that it saves cost and time (TalentCards, 2019). If well designed, developed and deployed within the organization, the need to send employees away to improve skills can be eliminated because learners will seamlessly access relevant content anywhere and anytime.

Similarly, micro-learning has proven to work well in academic institutions (Aigerim & Azamat, 2014; Polasek & Javorcik, 2019). Previous research indicates that a well designed and delivered micro-learning course coupled with immediate feedback improves learners' progress and productivity. Also, taping on the flexibility of micro-learning approach HEIs can opt to integrate micro-learning experience within the existing courses or to establish a dedicated micro-learning courses for distance learners to follow (Polasek & Javorcik, 2019).

More motivation factors of deploying micro-learning in education and other sectors are provided in section 2.5.2.

1.2.2 Micro-learning Technologies

It is unquestionable that the success of micro-learning depends on the availability of an enabling environment that supports the standard requirements. Especially, technologies that support creating, authoring, and publishing micro-learning content to the prospective learners are paramount. To respond to the micro-learning demands, a number of micro-learning platforms and applications are developed (Pappas, 2018). These platforms offer tools for creating and publishing content, tools for establishing and managing collaborations as well as tools for gathering and analyzing progress and continuity of the courses. In addition, they offer tools for instant feedback and integrity checkup. These platforms can be categorized in cloud-based applications, mobile apps, as well as standalone applications. Also, while some of the platforms are mainly free and open-source, the majority of the platforms are proprietary in such a way that the need for a license to use the platform is mandatory. In chapter 2, we provide a detailed discussion concerning the availability, application and important features of micro-learning.

1.2.3 Micro-learning Research and Deployment in Africa

Building on Brown's (2003) vision that Africa is more suited for mobile learning due to the infrastructural challenges, we investigated the state of micro-learning research concerning the continent. The search for Africa's place on the micro-learning literature was also motivated by our eager to see that Africa is able to leverage the micro-learning potentials for skills development. In fact, we explored the literature to identify the micro-learning initiatives, activities and research conducted on the continent so as to build our work on the findings.

Unfortunately, maybe because the micro-learning philosophy is still new, little is available concerning micro-learning in Africa. The absence of the literature about micro-learning activities in Africa provoked our desire to explore the situation in Tanzania. Therefore, the findings that we present in this dissertation might be the first attempt to review the state of micro-learning in Africa and Tanzania in particular. Specifically, critical discussions concerning stakeholders' perceptions, awareness, and attitudes towards micro-learning are presented in chapter 4. Also, in the same chapter, we explore issues related to individuals and institutional preparedness and readiness whereas the challenges that hinder the application of micro-learning in the higher education institutions are in chapter 5.

1.3 Statement of the Problem

Due to the fact that the micro-learning approach is still new much is needed to improve it. For example, despite the high popularity, micro-learning lacks theories and models that explain how to deploy it in various settings, including in higher education institutions. Similarly, the existence of a multitude of micro-units on the already crowded Internet makes it harder for learners to navigate and connect all necessary learning components (Bruck et al., 2012; Polasek & Javorcik, 2019). Regrettably, none controls the publishing of content on the Internet. Hence, there are no quality assurance controls in such a way that for inexperienced learners it is frustrating, time taking and risky. Also, other issues that need solutions concern hosting of micro-units, security, access as well as quality of the contents.

Further, while it is widely accepted that micro-learning can be integrated with various learning approaches within learning institutions, little is known on how such integration can happen. Also, there is no guidance on how to organize, design, and develop courses for the sake of enhancing quality (Sánchez-Alonso et al., 2006; TalentCards, 2019).

Thus, the existence of the identified problems as well as the lack of literature on micro-learning deployment in the East African context suggests that there is a need for more studies to improve micro-learning knowledge and research. Hence, the focus of this dissertation is on providing an understanding of the phenomena related to the enhancement of micro-learning access and deployment in higher education institutions in Tanzania. The detailed discussions of the outcome are detailed in chapters 4 to 8.

1.4 Focus and Scope of the Study

The overall conduct of the study is guided by the Design Science Research (DSR) philosophy, the Critical Theory of Technology (CTT) and the Connectivism learning theory. We were influenced by the fact that micro-learning services significantly rely on the ability of the education systems to set an enabling environment that ensures that teachers and learners are able to accomplish learning-related activities without being constrained (Chambo, Laizer, Nkansah-Gyekye, & Ndume, 2013). Such obligation does not fall sorely in the hands of technocrats; the micro-learning deployment is a democratic process that necessitates multi-sector and multi-level participation of all actors. The technocrats are responsible for translating the social requirements from the stakeholders into actionable and programmable artefacts that can be used to accomplish the social task (Feenberg, 2005).

Besides, the relevancy cycle of the Design Science Research methodology requires the involvement of those affected by the phenomena in the development of the solution (Hevner, 2007). Likewise, the CTT refutes the claim of leaving the process of designing and developing technologies in the hands of the technocrats. In order to ensure the relevancy of the artefacts from our study, we needed the Connectivism approach to provide the needed insight concerning what constitutes a learning environment for the micro-learning. Specifically, micro-learning fits well with the Connectivism's idea of learning in a connected world: learning is a network forming process in such a way that learners are responsible for traversing the Internet nodes to acquire knowledge and skills from various sources (Bell, 2011).

Likewise, to ensure quality, the DSR requires the developed artefacts to be evaluated to ensure they are able to accomplish the intended objectives. All of the artefacts (the Ujuzi App and the model) of this work are evaluated by using rigorous methods. In chapters 6&7 we present the critical discussions of the artefacts. Likewise, the DSR methodology was used to conduct the study in the four universities in Tanzania as detailed in the methodology chapter 3.

Because of the novelty of micro-learning and micro-credentials, it is hard to identify individuals with enough knowledge and experience on the two concepts especially in Tanzania. Particularly, our literature search for the two concepts pertaining to Tanzania ended in vain. Hence, in order to explore micro-learning in the HEIs in Tanzania, our scope was limited to the University of Dar es Salaam (UDSM), University of Dodoma (UDOM), Open University of Tanzania (OUT) and the Mzumbe University (MU) for pragmatic reasons. Because mobiles are banned in pre-university levels, it restricted the study to focus on the HEIs. These universities were chosen based on their diverse characteristics including their population, experience, and nature of their programs as well as history as described in section 3.3.2 of this dissertation. On top of that, we explored policy documents from all the universities to understand to what extent they support mobile and other learning technologies.

1.5 **Research Objectives**

Basically, the researcher is motivated by the need to contribute knowledge and understanding of micro-learning, particularly on the issues related to access and implementation in both formal and informal education setups. In the context of this study, the informal education setting refers to the learning experiences that happen outside the approved practices in the

university curriculum as described by Dib (1988). Both students and educators apart from classroom experiences they learn from anywhere and anytime. For example, students rely on online content to learn. They search for materials and dialogue with experts across the globe. Hence, we relied on informal and formal experiences to explore micro-learning phenomena in order to form a knowledge base for future studies. Moreover, he is triggered by the need to fill the identified theoretical and practical micro-learning gaps in the education sector. Hence, the overall goal of this study is to improve micro-learning access and deployment in higher education by using Tanzania as a case. More specifically, the study aims at the following:-

i. To explore the status of micro-learning and micro-credential implementation in the HEIs in Tanzania
ii. To explore the challenges that hinder micro-learning implementation in the HEIs
iii. To explore the role of brokerage services in the micro-learning access
iv. To develop the model for micro-learning deployment in the HEIs in Tanzania

1.6 **Research Questions**

In order to achieve the identified objects, we were guided by the following questions.

i. What is the state of micro-learning implementation in the HEIs in Tanzania?

   The question aimed at filling the literature gap concerning the state of micro-learning in Africa. Specifically, we explored issues related to the stakeholders' awareness, experiences, and attitudes as well as institutional and individuals' readiness in relation to micro-learning and micro-credentials including digital badges implementation. We provide the answer to this question in chapter 4 of this dissertation.

ii. What are the challenges that hinder micro-learning implementation in the HEIs?

   As the question suggests, we aimed at identifying all issues that limit the performance as well as the implementation of micro-learning and micro-credential in the HEIs. The identification of the challenges helped to develop the model as well as devising recommendations to the stakeholders and research communities. In chapter 5 of this dissertation, we provide a detailed discussion concerning the identified challenges.

iii. What are the roles of brokerage services in the micro-learning access?

   In chapter 2 we provide discussions concerning the access challenges associated with the design and architecture of micro-learning. This question concerns the application of brokerage services to mediate communications and interactions between learners and

providers. The ultimate goal is to fill the access gap identified in the literature. In chapter 6 a detailed discussions that answer this question are presented.

iv. What can be the model for micro-learning deployment in the HEIs in Tanzania?

Lastly, we identified the lack of framework, model and theories related to deployment as a theoretical gap. Based on the collected data and participants' recommendations we identified constructs for the model. Then, the constructs were associated to build a proposed micro-learning deployment model in chapter 7. Because we emphasize the application of brokerage services to enhance micro-learning access, we refer the model as brokerage deployment model.

1.7 Justification for the Study

The state of micro-learning research and implementation across the globe justifies the need for studies like this. There are a number of unanswered questions regarding the manifestation of micro-learning in the education sector. In this dissertation, we present the importance of micro-learning in facilitating skills acquisition, focused and lifelong learning. Also, we reveal various ways in which micro-learning can be deployed including being blended with the existing systems. In addition, we have uncovered the state of micro-learning as well as challenges that need to be addressed. Specifically, the study managed to produce the following contributions:

i. The theoretical contribution through the model for deploying micro-learning services
ii. The recommendations for the stakeholders to consider when deploying micro-learning services
iii. Filled the theoretical gap regarding the role of brokerage services
iv. The Ujuzi App that will be used to expand micro-learning services at Mzumbe University

1.8 Organization of the Dissertation

The present dissertation is organized into eight chapters. While each of the chapters is self-contained, self-informing and independent, when combined together they form and share one common message --*Micro-learning and Micro-credential Approaches are Important, Possible and Implementable, just play your part.*

Chapter 1: General Introduction; in this chapter, we provide the overall setup of the study. In particular, we briefly introduce the topic, the motivation, and the justification of

the study. Also, both the research questions and objectives are discussed in this chapter.

Chapter 2: Micro-learning Deployment in the Higher Education Institutions: Conceptual and Theoretical Issues; in this chapter, we provide detailed discussions concerning the concepts related to micro-learning and micro-credentials. In addition, we explore the state of literature concerning the two concepts including theories and technologies.

Chapter 3: Research Methodology; in this chapter, we start by describing our position concerning research philosophy: ontology and epistemology. Then, the methodology and methods linked to the philosophical choices are revealed. In addition, we reveal how the study observed ethical requirements.

Chapter 4: Micro-learning and the Higher Education Institutions in Tanzania; in this chapter, we report on the situation analysis conducted in the four Universities. Specifically, the status of micro-learning and micro-credentials in HEIs in Tanzania is revealed in this chapter.

Chapter 5: Challenges for Micro-learning Deployment in Higher Education Institutions of Tanzania; it addresses the objective two of the study. We provide detailed discussions concerning challenges as required by the objective two of the study. The chapters 4&5 form the basis for the model presented in chapter 7.

Chapter 6: The Role of the Brokerage Services in Micro-learning Deployment: the case of the Ujuzi App Implementation at Mzumbe University; the chapter reveals the role of brokerage services in mediating communication between learners and providers of micro-learning. Also, in this chapter, we discuss issues related to authentication and quality controls. In addition, we describe how the Ujuzi App is developed and implemented at Mzumbe University. The chapter addresses the objective three of the study.

Chapter 7: A Micro-learning Deployment model for Tanzania Higher education institutions; the chapter proposes the model for micro-learning deployment in higher education in Tanzania. Together with the model, the factors that influence success are described. It addresses the objective four of the study.

Chapter 8: Summary, Conclusions, and Implications; the chapter presents the general conclusion and overall findings of the study. Also, it identifies the limitations of the study and suggests areas for further studies.

CHAPTER TWO

MICRO-LEARNING DEPLOYMENT IN THE TANZANIAN HIGHER EDUCATION INSTITUTIONS: CONCEPTUAL AND THEORETICAL ISSUES

2.1 Introduction

This chapter explores extant conceptual and theoretical discourses relevant to micro-learning deployment in higher education institutions with specific focus to the Tanzanian higher education institutions. We present what is already known in the literature as well as identify knowledge gaps. The chapter also underscores how micro-learning is deployed and applied. This chapter offers the basic understanding of phenomena surrounding micro-learning research and related concepts across the globe on which this study rests.

In order to ease the flow of the content, the chapter is organized into nine sections. The chapter introduction (section 2.1) announces the background information in section 2.2, where the position of mobile technologies in our society is contextualized. Then we provide the research framework in section 2.3. Next, Section 2.4 addresses the link between the micro-learning concept and mobile learning (m-learning) to provide a detailed analysis of the status and limitations of m-learning, which subsequently called for the introduction of micro-learning. Section 2.5 is dedicated to discussions pertaining to micro-learning, the focus of this study. In section 2.6, we provide a critical review of the theories and models related to the deployment of technologies. Because of the deficits in the existing theories and models, the analysis of the framework used in the study is presented within the same section. In section 2.7 and 2.8 we provide a discussion of the related concepts to micro-learning: brokerage services and micro-credentials respectively. The chapter ends with the summary and concluding remarks in section 2.9.

2.2 Background Information

The advances in mobile computing, mobile broadband and wireless technologies have transformed how we conduct our lives and businesses. Ideally, modern mobile devices (i.e. mobile phones) are feature-rich; they are capable of supporting communications conducted in various forms including video, audio and text. Also, they are equipped with context-aware features such as camera and GPS. They have storage and processing capabilities necessary for performing computational and analytical works. Mobiles (as it is used in this dissertation include smartphone, tablets, feature phones, cell phones etc) have become ubiquitous in our lives due to their flexibility, portability, affordability, and easy-to-use multi-functionalities.

Further, due to the interactive and collaborative nature of the mobile applications ('apps'), the world is experiencing significant shifts in all sectors including education, manufacturing, health, tourism, business, politics and social services. In fact, by the end of the year 2017, the world had at least five million (5 million) mobile applications in the two popular app stores: Google and Apple store (The Statistica, 2017). These statistics justify the existence of a multitude of studies conducted in the area of mobiles from different perspectives.

The high proliferation of mobiles and their associated applications have forced businesses and individuals to formulate meanings so as to leverage from the phenomena. The way mobile technologies are conceptualized and applied differs from one society, individual and one group to another as well as between the designer and the user. In fact, it is true according to critical theorists of technology that each technology is shaped by the interactions between its design and social-cultural values obtained from debates in the societies (Feenberg, 2005). The way technology is used depends on the context to which it is applied. Hence, while mobiles might be perceived as a tool for leisure and entertainment in other parts of the world, in Africa they are a tool of hope and liberation, they connect remote and marginalized communities to the rest of the globe to access basic services as well as to participate in local and global debates. There is no doubt that "mobility is power and liberating" (Adams, 2005).

In education, mobiles have become an active area of research and critics for over two decades. The majority of students and teachers own and use mobiles in their lives (Joyce-Gibbons et al., 2018; Mtebe & Raisamo, 2014). Significantly, mobiles are proven to be useful in providing access to learning resources, learning communities as well as adding interaction and collaboration, hence improving the learning experience (Mtebe & Raisamo, 2014). Yet, unregulated deployment of mobiles in schools proves to be a challenging and humiliating experience to some students, teachers and families. Also, not all mobiles deployment into various undertakings including education has lived up to the expectations, this due to a number of reasons discussed further on (Isaacs & UNESCO, 2012; Jaffer, Ng'ambi, & Czerniewicz, 2007). The cited works justify the conducting of more research to further enrich our understanding of the roles of mobiles in today's world.

The focus of this work is on the intersection between mobiles and learning. Our approach uses mobile learning to explore micro-learning deployment in higher education institutions because the two concepts are closely related. Therefore, the following discussion provides a critical account of mobile learning as it shapes our work of micro-learning deployment without ignoring the overlap of the two concepts and associated discussions.

2.3 Research Framework

This dissertation is a result of the combination of works by many individuals as acknowledged earlier. In order to achieve the intended result, we needed a framework to provide direction. In this section, we reflect on the way the research was organized and conducted by looking in the research framework (figure 2-1).

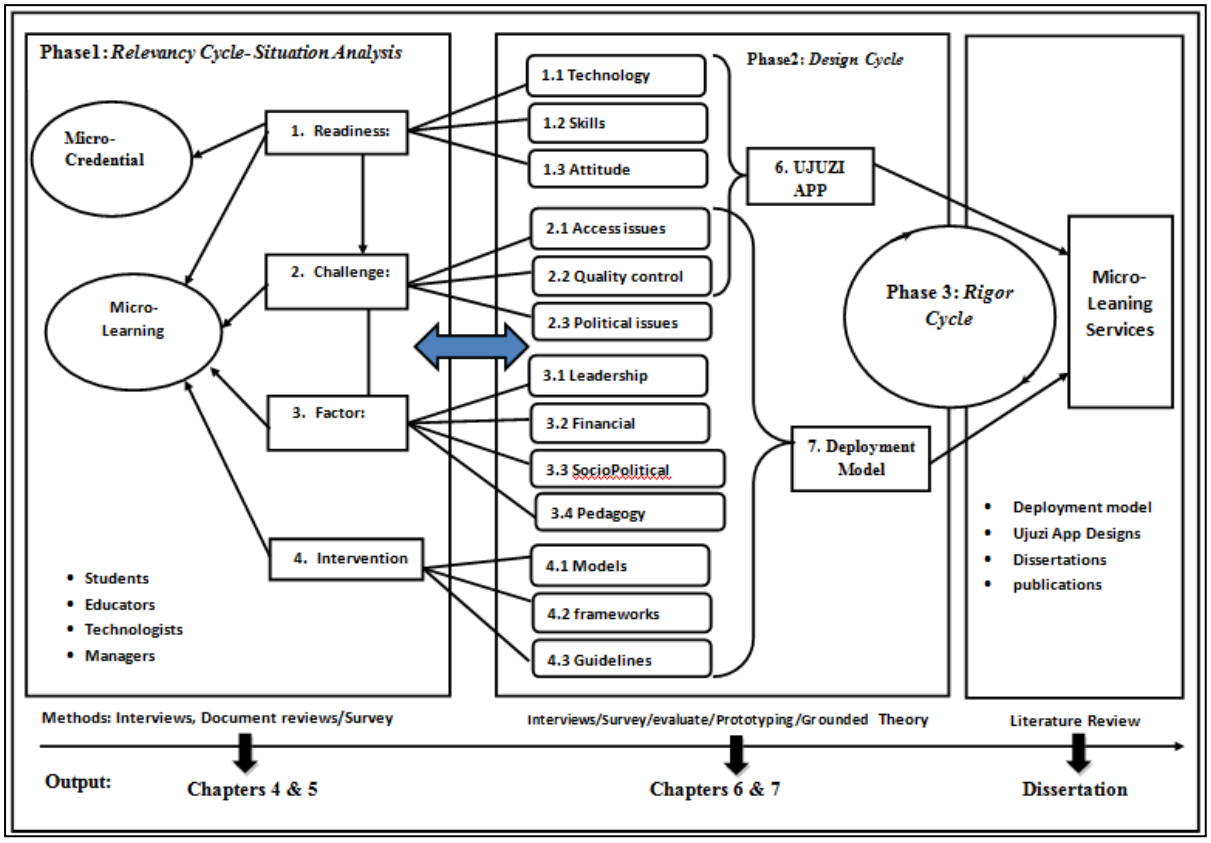

Figure 2-1: Research Framework

In particular, the framework reflects the DSR approach that is the main philosophy of the study to ensure the outputs are relevant and rigour. During phase-1 of the study, as required by the relevancy cycle, it involved exploration of the HEIs to discover issues related to micro-learning and micro-credentials. By the aid of literature and document reviews, interviews as well as surveys, we explored readiness (1) issues, challenges that hinder acceptance and deployment (2), factors that influence successful deployment (3) as well as means of interventions (4). The results from the phase-1 help to answer the first two questions of the study (see chapter 1). Significantly, the phase-1 results are discussed in chapters 4 & 5).

Similarly, during phase-2, as required by the design cycle, data collected in phase-1 were analyzed and organized to design and develop two artefacts: Ujuzi App and a micro-learning deployment model. Also, as required by the DSR, the artefacts were evaluated by the experts

and stakeholders to check their efficacy, validity and if they perform as expected. The results of the evaluations help to answer the last two questions of the study (see chapter 1). Hence, the phase two outputs are the two artefacts as well as discussions in chapters 6 & 7.

Moreover, during phase-3, as required by the rigor cycle, it involves grounding DSR results in the existing theory as well as communicating them to the general public and experts for the sake of improving knowledge. Overall, results of the project as well as the artefacts, are communicated through this dissertation as well as publications we have made to the journals including Ghasia, De Smet, Machumu, & Musabila, (2018a) and Ghasia, Machumu, & DeSmet, (2018b).

Furthermore, this framework provides guidance on issues related to literature reviews as well as the proceeding discussions concerning micro-learning and its associated concepts including theoretical discussions.

2.4 Understanding Mobile Learning

Informed by the high proliferation of mobile technologies (devices and applications), educators, researchers and education stakeholders are in search of the position and meanings of the highly afforded and used devices. Central to m-learning discourse are the topics of affordance, mobility, flexibility, accessibility and connectivity. However, the definitions of each, and the importance attached to each varies among scholars. Various scholars define m-learning by focusing on technology, learner's mobility, content as well as learning experience achieved in the process as detailed in the following sections. Generally, most attention is paid to raising access by increasing flexibility, connectivity, mobility and affordance at the level of format, learner and learning.

Starting with the technological view of m-learning, scholars describe it as any form of learning that is mediated through mobile devices, the hand-held devices of various types that permit learning to happen through various formats (Brown, 2005; Muyinda, Lubega, Lynch, & van der Weide, 2010). The focus of this view is on the delivery of the content to learners based on the characteristics of their devices regardless of the vicinity. As we know, the ecology of mobiles consists of a diverse range of devices with varying capabilities and affordances as well as capability of performing activities in various formats. Therefore, it is important to devise strategies that will ensure the delivery of learning experience to learners regardless of what devices they use. These strategies to raise format accessibility include the

design of the course, content; assessment methods and activities that reflect media intended to be used.

The second view is that of associating m-learning with the mobility of the learner (Jones, Scanlon, & Clough, 2013; Kukulska-Hulme, 2007; Traxler & Leach, 2006). In this view, the learner is embodied in a person who either shifts spaces between schools and away from school or a remote learner in a formal or informal setup. Also, the learner is a person on the move (travelling or commuting). Thus, the emphasis in this definition is to liberate and empower learners so that they participate in the learning process regardless of their situation, location and time. Whether m-learning is blended within other learning approaches or applied in the dedicated mode, learners should be able to learn within and beyond the boundaries of the universities or schools (Ally, 2009; Kukulska-Hulme & Traxler, 2005). Hence, educators, policymakers, administrators and education-stakeholders are responsible for establishing the enabling environments and infrastructure that guarantees availability and access to the learning resources and activities. Also, they are responsible for formulating policy and strategies that will inspire creativity and innovations as well as the provision of required support for learning to happen. We note the link between enhancing learner accessibility and the stimulation of social innovation. For example, social innovation can be in the field of policies ensuring that devices are affordable and accessible to all learners regardless of their socio-economical status.

Further, m-learning is defined based on the content and learning experience. The argument prominent to this view is that having access to mobile devices – hence attaining format and learner accessibility - does not guarantee learning to occur. It is not the technologies that make learning, but the combination of many factors including pedagogical values, strategies as well as administrative support. It is asserted that, for learning to occur, the design and delivery of courses, how institutions provide support to learners and teachers, and content of the developed policies need to complement each other. On top of that, the attitudes and abilities of learners, as well as teachers and administrators, impact learning processes and experiences. For example, distance learners have no access to visual contact with the teachers; their success depends on the well-developed content, interactions, information as well as communication with the universities. Also, the learner needs to feel connected to the learning institutions (Moore, 1993). It is argued that reduced transactional distance due to the increased autonomy, through interaction and collaborations help learners to configure their learning styles and take control of their learning processes (Moore, 1993, p. 26).

In principle, regardless of which viewpoint one subscribes to, m-learning is deemed to transform traditional teaching and learning approaches by extending the learning experience beyond the walls of the universities and schools. Moreover, it shifts control of the learning processes from teacher to students (student-centred) in such a way that teachers' roles are limited to facilitating and mentoring instead of being the sole knowledge generator (Siemens, 2014). Furthermore, learning is becoming a constructive and social endeavour; learners are taking ownership of the learning process and form collaborative networks with other learners and other scholars. The challenging aspect of this viewpoint is how to equip educators with relevant skills and attitudes capable of transforming their approaches to fit the new demands.

In connection, m-learning is regarded as a means to extend learning experiences to the marginalized and remote communities disconnected from the public infrastructure in the rest of the globe. The majority of societies in rural Africa have no access to telecommunication infrastructure as well as electricity due to several reasons, including poverty and lack of good governance (Isaacs & UNESCO, 2012). Hence, remote learners, especially in underdeveloped regions, lack access to global learning resources, quality teachers and even substantial basic needs (Brown, 2003). The lack of an enabling learning environment contributes to a high number of school drop-outs. In fact, there are over 42% of dropouts in African schools (UNESCO, 2012). Therefore, increased access to mobile devices provides opportunities for these groups to participate in learning processes from where they might be, regardless of whether the setting is formal or informal.

2.4.1 Mobile Learning is not E-learning

In the past decade, m-learning has been closely associated with the illustrious electronic learning (e-learning) in the sense that e-learning comprises all forms of learning that happen or are mediated through electronic media. Because they are closely related, we find it to be of great importance to make a clear distinction between the two and expand our understanding of the two concepts. E-learning became popular with the spread of the Internet and personal computers (PC). It led to the development of learning management systems (LMS) that support the creation and delivery of content for the learners' computers (Abu-Al-Aish, 2014; Ally, 2009; Brown, 2003). LMS such as Blackboard, Moodle, Sakai, and Canvas are equipped with features capable of assisting educators, especially teachers in the process of creating and administering courses, delivering content, monitoring participation as well as assessing learning outcomes. Due to the connecting power of the Internet, universities and

schools with adequate infrastructure are able to deploy LMS based courses into their servers for students to access from computer laboratories as well as using their private computers.

In contrast, for students who cannot be reached through the Internet, especially remote learners, other modes of delivery were used, including recorded audio and videotapes on media such as disks as well as printed materials, which students use to read and interact with. Much of the communications happen asynchronously through postal offices. This meant for the remote students that learning became a frustrating experience, due to the transactional distance between learner and educators as well as between learners themselves (Moore, 1993). Gradually, e-learning forced academic institutions to invest in vast infrastructure to support learning, while educators were responsible for designing and developing pedagogically rich content and activities (Ally, 2009; Kukulska-Hulme & Traxler, 2005). Yet, the commitment was hard to realize by underprivileged learners and institutions.

Unfortunately, despite the commitments from education stakeholders, e-learning is yet to satisfy demands of the marginalized and remote communities, especially in underdeveloped counties where they lack skills and infrastructures. Also, it has failed to fulfil the promise of offering learning "anywhere" and "anytime" especially to learners on the move (O'Malley & Fraser, 2004). The computers are not as portable as they should, and the networks have not reached the level that mobile-wireless is today. Hence, the invention of mobiles provides learning the needed bridge to extend learning to where e-learning could not. The majority of scholars believe that although m-learning is a sub-set and natural extension of computer-based e-learning (Brown, 2003), it has the greater potential to provide access in the wider society as well as bring about the new philosophy of learning (Siemens, 2014).

Significantly, m-learning is an ideal invention for education systems in areas such as Africa facing several challenges including over-crowded classrooms, limited access to scholarly resources as well as a low number of qualified experts in some key fields (Brown, 2003; Isaacs & UNESCO, 2012). It helps educators and education institutions to extend their reach even beyond the boundaries of the classroom. Also, it allows learners to decide when, where and what to learn, thus learning is more personalized. Also, mobiles, especially through apps, facilitate interaction and collaboration in such a way that learners can interact between themselves and with teachers more efficiently and become part of the knowledge production chain (Holzinger, Nischelwitzer, & Meisenberger, 2005). Further, m-learning is proven to help bring equity, quality and access to education to more groups than before (Isaacs & UNESCO, 2012). It is applicable in formal and informal setups of education.

Due to their portability, multi-dimensionality, and multi-affordances, mobiles are applied in diverse ways. As described before, mobiles can be used to deliver learning content as well as activities in various formats, including audio, video as well as texts. They are used to access and browse the Internet, multimedia contents as well as SMS based services (Duncan-Howell & Lee, 2007; Muyinda et al., 2010). In addition, the context-based features offer possibilities to deliver learning based on the location and other characteristics of the learner's environment. What is important is the ability of the learner to access and use technologies as well as educators to embed pedagogical values that make learning authentic and relevant (Jaffer et al., 2007; Traxler & Kukulska-Hulme, 2016).

2.4.2 Mobile Learning Components

M-learning happens due to the interactions between the number of components including technologies, pedagogy, people as well as rules and procedures. First, technologies consist of hardware and software that form basic parts of mobile devices as well as technical infrastructure that manifests capabilities achieved by the devices. Second, pedagogy includes all sets of political and social arrangements that dictate how learning is organized and occurs in a particular setting. They include issues such as curriculum, assessment methods, delivery approaches, as well as quality controls. Although demand for knowledge is believed to be universal, the exact needs for each society are shaped by social, political and economic variables. Hence, pedagogical considerations hold a significant value in the design and delivery of m-learning experiences. Third, people represent people who are central to all operations that happen during the learning processes. They include teachers, administrators, learners, as well as policymakers. These components contribute to either success or failure of m-learning implementations as detailed in the coming paragraphs.

Therefore, it is necessary to consider the value of technologies when dealing with any technology-mediated learning approach. The technologies determine the general operation of the related activities. Especially, mobiles are of various versions and capabilities in terms of software and hardware. Their capabilities determine the kind of activities that can be performed, the type of content that can be delivered or accessed, the mode of delivery that can be achieved, as well as the kind of learners who can afford a specific learning platform. The hardware of the mobiles differs in terms of capacity: storage media, processing power, screen and keyboard size, broadband inputs as well as general devices size (Holzinger et al., 2005; Kukulska-Hulme, 2007). Importantly, hardware capabilities determine not only the

course parameters but also the software and applications to use. Hence, it is crucial to profile devices that learners use before deciding the content and the delivery format and media.

Also, software choices are mainly operating systems (OS) and applications. The OS of a device controls all operations and resources in the device. The OS controls and monitors how each system's devices operate, including user-installed applications. Also, the OS is the interface between devices, applications and users in such a way that through them tasks get accomplished by the hardware. Significantly, the OS choices affect how and what software and application can be installed in a device (Joorabchi, Mesbah, & Kruchten, 2013).

Moreover, they affect the way users interact and experience a given technology. There are a handful of mobile OSs including Androids and iOS developed by Google LLC and Apple Inc. Unlike the computer-world where most of the computer hardware is OS independent, the mobile OS supports a specific set of hardware and applications. This makes mobile apps OS-specific; they can only be accessed and used within the same OS and not otherwise. For example, apps developed for Android cannot be used in iOS, and vice versa. On top of that, within each OS family especially for Android, there are variations in terms of versions and feels. The application developed for one version might not perform the same in versions that are either lower (earlier) or higher (later). In brief, the user's OS-specificity raises pressure on the developer to ensure format accessibility.

Further, learning in the m-learning era happens spontaneously, anywhere and anytime, thus requiring persistent connectivity. Access to learning devices as well as wireless and infrastructural technologies, including electricity for charging devices is crucial. Also, connectivity includes the ability to subscribe and pay for broadband services. Evidently, it is a multi-player, multi-sector and multi-level undertaking. Some requirements fall beyond the jurisdictions of the learning institutions, learners and educators. They include the availability of enabling policies, financial capital, social services as well as a mechanism to blend all the requirements into one functional unit. These requirements determine the possibility of institutions to deploy m-learning as well as the ability of the learners to access the learning services regardless of their temporal and permanent contexts.

Furthermore, OS fragmentation forces academic institutions to choose between native[1], web-based[2], and hybrid[3] applications (Joorabchi et al., 2013). While native mobile apps are highly

[1] Native apps are developed by using programming languages native to the specific Operating Systems (OS). They are installed within the mobile devices. OS of the device controls the overall operations and resources related to the apps (Joorabchi, Mesbah, & Kruchten, 2013)

rated in terms of performance, feature richness as well as appearances, they are OS-specific; they cannot be used in more than one OS. For example, native Android apps cannot be implemented in iOS etc., and vice versa. An exception is web-based mobile applications (web-apps), which run through the native browser of the OS. Although they are cross-platform, they are reported to be slow and not efficient compared to the native applications in applying rich mobile features such as camera, GIS and microphones (Dossey, 2019; Perera, 2019). Nevertheless, they are known to be economic and effort-efficient because once they are developed, they can be accessed by all major OS users without requiring the re-designing for each platform as required by native applications.

Therefore, the choices of m-learning deployment approaches and modalities are influenced by the technology at hand (Isaacs & UNESCO, 2012). Whether to provide devices to learners or to require learners to bring their own devices (ByD) depends not only on whether learners are able to afford devices that fit software requirements but also the capability of the institutions to deploy applications that fit the fragmented landscape of learners' devices (Muyinda et al., 2010). Another issue is the ability of institutions, learners and educators to cope with the ever-changing software landscape in all the platforms. Hence, it is important to explore relevant technologies for each learning context before deploying such services. Indeed we explore challenges that hinder the deployment of m-learning services.

Apart from technology, successful m-learning depends on the embedment of pedagogical values into learning settings. It is widely argued that the biggest problem in m-learning implementations, especially in Africa, is linked to making choices based on directly available technological possibilities rather than pedagogical and business needs (Jaffer et al., 2007). It is believed that quality and meaningful m-learning will only happen if educators can inscribe pedagogical value into the technologies (Duncan-Howell & Lee, 2007). Also, quality depends on the policies and overall management of the education sector far beyond the institutional level. Policies should clarify how to facilitate and manage the use of information and communication technologies (ICT) such as mobiles in schools.

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[2] Web-based apps are different. They are based on the web architecture. Applications are stored in a web-server. Access to the app is performed through the native browser of the mobile devices. Because of the limitations of the mobile devices, these applications are specifically customized to fit the environmental conditions. Because they are not installed within devices they are platform independent (Han Rebekah Wong, 2012).

[3] Hybrid apps are a special category of native apps. Because they are developed using open architecture, they are cross-platform. They perform better than the web-based applications in terms of speed as well as the ability to utilize native features of the mobile devices such as the camera (Han Rebekah Wong, 2012).

Similarly, in order to achieve m-learning success, it is vital for institutions to have a critical number of qualified individuals. They include educators who are responsible for defining, designing, developing and delivering course curricula as well as appropriate content. Also, educators create activities and administer overall conduct of the course, including assessing participation. Their ability to vision and perform their obligations significantly affects the outcomes. According to Schmid (2006), teachers' pedagogical belief and proficiency, as well as their technical proficiency, directly impact the quality of delivery. In connection, educators work with administrators who are responsible for coordinating and managing resources and environments to support learning, learners and educators. They are the systems administrators and education technologists responsible for technological infrastructures as well as managers responsible for finance, human resource, policy and strategic decisions. That conforms to the argument that deployability of technologies is impacted by the availability of the leaders who have technological and innovative characters.

Furthermore, the ability to motivate and coordinate activities and teams into meeting the agreed objectives is vital. Nonetheless, part of this study explores institutional readiness towards micro-learning deployment. Specifically, we explore infrastructure, people, as well as policies and procedures.

2.4.3 Mobile Learning Projects and Research across the Globe

Like other learning technologies, allocating the position of mobiles in education has been under intensive study across the globe for over decades (Abu-Al-Aish, 2014; Isaacs & UNESCO, 2012). Since its inception, mobile technologies have been deemed to be more than just assemblages; they have the potential for systematic re-configuration to fit and address social problems. The majority of the early studies focused on the applicability, practicability and usability of mobiles in various education settings. They include studies on individuals and institutions readiness, acceptance, perception and ability for learning to happen through mobiles. Together with these studies are projects and initiatives that aim to explore options that mobiles can be used to accomplish various aspects such as classroom-based, online and offline, context-based learning as well as formal and informal systems (Jones et al., 2013). Moreover, previous studies helped to shape our understanding of m-learning and their application in education. Especially, they have provided clarity to the possibility to learn through mobiles. They offer explanations on several modalities and approaches to implement m-learning in informal and formal education systems. In the next paragraphs, to highlight the

state of literature concerning m-learning, we provide detailed discussions concerning some projects and studies conducted around the globe.

The UNESCO working paper series on m-learning provides comprehensive findings from intensive studies of mobiles application in education systems across Africa, Middle East, Asia, Europe, Latin America, and North America (Isaacs & UNESCO, 2012). They include studies on how mobile technologies are used to improve educational access, equity and quality as well as ways in which they support and improve teachers' pedagogical and administrative practices. These studies applied both qualitative and quantitative methods. According to these studies, the education stakeholders across the regions, including teachers, students and policymakers indicated a positive trend towards mobile technologies adoption and used in education. In these locations, mobile phones that are positively perceived by the majority as a tool for leisure and entertainment are evidently proven to support teachers' pedagogical and administrative development. Mobiles are useful in various ways including for curriculum delivery, communication and provision of advisory supports. Drawing from a diverse range of mobiles initiatives such as the MoMath project in South Africa, the Bridgeit in Tanzania, and the road to reading in Mali, students argue that mobiles are useful tools in education (Isaacs & UNESCO, 2012). Through mobiles, teachers and learners can access and deliver learning resources and content, communicate and interact with peers and students, perform or administer school activities such as quiz and more. However, for such to happen, political, technical and economical interventions are needed especially in the remote, poor-resourced, and marginalized communities of Africa.

Likewise, the Mlearn project, funded by the European commission builds pedagogical and technological capacity to teachers (from primary and secondary school) in four member countries (The United Kingdom, Netherlands, Greece, and Italy) on how to productively apply the handheld devices in their classrooms (Barker et al., 2005). Motivated by the increased access to mobile technologies by students and teachers, the project facilitates the integration and usage of mobiles into education. Teachers from four member states are equipped with technical and pedagogical skills as well as technologies to deliver learning to students of various age groups from kindergarten to secondary and vocational training. Based on the survey administered to learners and teachers, it was revealed that both students and teachers were satisfied and motivated by the use of mobiles inside and outside classrooms. Further, both students and teachers felt that mobiles provide an additional layer for engagement, an interaction that makes collaborating and sharing of education and socially

related information and activities more appealing than before. Also, it was realized that mobile devices provide opportunities for personalized, innovative, borderless, timeless learning, as well as enhancing motivation to learn (Barker et al., 2005).

Similarly, Corlett et al. (2005) evaluated the usefulness of mobile learning organizer-software at the University of Birmingham for over ten months. The software was implemented in pocket PC handheld computers. Also, it considered the existing mobile applications widely used by students in their daily activities. These applications support communication, time-management and interaction between students and teachers. Although the project was hampered by the low Internet speed and unfriendly user interfaces, the outcome reveals that students recognize the importance of mobiles in their education. Also, results suggest that institutional supports are crucial to successful deployment initiatives. More practical, the study recommends the availability of suitable infrastructure to support learning.

Also, m-learning has proven to be effective when applied in informal settings. For example, Traxler & Kukulska-Hulme (2016) researched the use of "RehabMaster mobile" in the healthcare environment. It is a mobile learning application for stroke patients. The project offers critical and constructive emphasis on how "utility" mobiles can be effectively modelled to fit and address different social problems. Through the lens of activity theory (AT) and expansive learning theory (Lee, Kim, & Ryu, 2016), stroke patients and medical professionals participated in the design and creation of m-learning space that helped stroke patients and caregivers to connect in the trusted communities where they could exchange their feelings, experiences and seek moral and professional advice (Traxler & Kukulska-Hulme, 2016). The learning environment became a medical laboratory where non-scientific and unauthenticated practices were scrutinized. The app helped to strengthen interactions, collaborations as well as a sense of belonging amongst community members. This work reaffirms (see figure-1) our understanding that learning through mobiles becomes authentic value-adding, provided there are relevant social needs, commitment as well as enabling environments (policy, infrastructure, and people) to achieve the intended goals.

Recently, context-based and location-based learning has drawn a large number of interests from scholars to explore possibilities and capabilities. Principally, some mobiles, especially modern devices, are equipped with context-aware technologies that are capable of identifying parameters of the learners' environments (Traxler & Kukulska-Hulme, 2016). By leveraging from such technologies, it is possible to offer a targeted learning experience based on the learner's context. By context, we refer to the situations surrounding learners' learning

environments. For example, the Geocaching and personal inquiry research in informal and semi-formal settings highlights the usefulness of mobiles in supporting learning activities (Jones et al., 2013). Based on two narrated cases, it can be posited that the context-aware features support learning processes in a way reflecting the traditional 'context-aware' interaction with a physically present teacher if well embedded within off-school study designs and activities such as study tours, museums studies as well as Geocaching. They connect learners to access resources, enable communication and engagement of the participants as well as empower learners to control what, when, and whether to learn. When applied in the personal enquiry case, through the use of inquiry software and web application and net PC, students were successfully able to carry out their learning activities in the absence of their teachers. Likewise, Geocachers had full control of the learning objectives as well as processes by aid of the mobiles (Jones et al., 2013).

Similarly, students' perceptions, behavioural intentions and readiness towards mobile learning have been explored by researchers (Hussin, Radzi Manap, Amir, & Krish, 2012). Results suggest that the majority of the university students across the globe including sub-Sahara Africa own mobile phones. They use devices to perform academic and non-academic activities. However, students' ability to access and subscribe to mobile-internet differs from one situation to another and among students. For example, whereas the study conducted by Hussin et al. (2012) in Malaysia reveals that almost 37% of students could not subscribe to the Internet daily, Mtebe & Raisamo (2014) reveal a high number of students who have access to the Internet thanks to mobile phones. Also, despite the identified difficulties, the majority of respondents in all of the studies are positive about m-learning deployment in education (Abu-Al-Aish, 2014; Chambo et al., 2013; Mtebe & Kandoro, 2016). In addition, it is revealed that institutions' readiness in terms of infrastructure, skills and budget is important when considering technology-mediated learning deployment. Therefore, prior to developing a micro-learning model for the higher education institutions in Tanzania, we conducted a readiness test to explore situations in the identified universities (see chapter 4).

Next, the MoMath project in South Africa and Finland represent a variety of mobile applications in a formal setting, especially the pre-university level. Following the request from the South African president to explore the possibilities of mobile technologies to support formal education, Nokia together with stakeholders from public and private sectors conceptualized and implemented the project. The project expanded from six school pilot projects to over 150 in all provinces (Roberts et al., 2015). The project offered access to

mobile-based grade-10 mathematics content and activities to over 180,000 students and teachers across the country. Identical to the MoMath implementation in South Africa, the content and activities were successfully implemented in Finland's education system. The system offers a questions bank consisting of over 10,000 interactive questions for students to practice on their mobile phones or through the mobile-kits provided to schools.

The MoMath project is hailed worldwide for its success in improving learners' performance, attitudes and motivations toward learning mathematics. Also, the application improves interaction amongst students and teachers. It highlights the need for leadership, budget, vision, as well as a business model that reflects the social context. It is important to involve stakeholders in the process of systems deployment. For example, the MoMath team composed of key stakeholders, including educators who facilitated the integration of the SA curriculum into technological designs.

On top of that, the project teams managed to evaluate and act on the negative aspects of the project and technologies in time. For the digital illiterate students, special supports were offered through pear and schools. Likewise, because of the poverty of some students, the project offered "mobi-kits" consisting of mobile phones to schools. The "mobi-kits" contained mobiles that were loaned to students so as to bridge the digital gap. In the end, students from all socio-economic groups were empowered and liberated (Isaacs & UNESCO, 2012).

Similarly, Microsoft conducted a mobile mathematics study in South Africa from 2008 to 2015. The project evaluation reveals the importance of strategic planning and implementation of technologies based on the context of the learners. Further, it was noted that the value and scope of the proposed spectrums (learning spectrum, kinetic spectrum, collaboration spectrum, access and affordability spectrum as well as a pedagogical spectrum) vary from one context to another (Roberts, 2016). While at the pre-university levels they rely on the pre-defined learning curriculums that take place in classrooms, universities have the freedom to decide from the available alternative ways to deliver a course. The design of the course defines ways in which learner access learning materials and activities. Also, issues such as whether learning takes place in class, on the go or at home depend on the course design as well as learners technical and political contexts. Therefore, it is crucial that both learners and teachers are able to perform their responsibilities without being constrained in terms of accessibility, affordability as well as the ability to use technologies productively (see item 1.2 in figure-1). Consequently, we will in this study have to explore the actually encountered

'real' phenomena in higher education institutions in Tanzania before we suggest relevant approaches and technologies for the learners and teachers.

The presented projects and researches represent just a few successful cases of m-learning studies and implementations across the globe. We are also informed about other works such as the EDUCAUSE and MoLeNET activities targeting different aspects of teaching and learning among diverse social groups, including the disabled. Regardless where it is implemented, m-learning is yet at its infancy in terms of theory, application and model of delivery. Most projects and research that are carried out target specific groups. We are yet to uncover comprehensive theories and deployment models that cut across different contexts. Also, contradictions arise on how to measure success and failure of the implemented projects. For example, while to some literature the success is measured based on the successful implementation and the learners' ability to use the technology to conduct learning, the lack of pedagogical values, as well as sustainability of the projects, signifies failure in other literature (Traxler & Kukulska-Hulme, 2016). In addition, national and institutional policies play significant roles in shaping the outcome of the projects; they define vision, priority and commitment towards resource allocation and utilization of the technologies. For example, mobile learning will not flourish in environments where mobiles are banned from school premises (O'Hagan, 2013).

At the heart of the m-learning projects and researches are varied needs and purposes of m-learning implementations. While to the developed world, m-learning deployment permits innovative ideas towards enhancing and extending methodological approaches to learning, the step to m-learning becomes critical in resource-deprived countries -- effectively a rescuer and liberator of education. The model of deployments varies according to the context (social, technological and political). When the context is characterized by rich resources in terms of infrastructure, technological knowhow and positive digital culture, then the more sophisticated and media-rich learning technologies, content and activities are possible. But when the social-economic conditions are not satisfactory, the design and delivery of m-learning becomes complex because of the difficulties that hinder the success of deployment. For example, the MoMath projects in South Africa could not be successfully implemented without offering free services and mobile-kit to schools. Such diversities impact the design, deployment approach, and micro-learning deployment spectrums championed by (Roberts, 2016). Therefore, we argue for context-wise deployment approaches and models of m-learning services as we proceed to the next section.

2.4.4 Contextualizing M-learning in African Education

Brown (2003, p. 123) claimed that Africa is more suited for m-learning due to the infrastructural challenges. Still, Africa's education systems suffer from limited expertise, crowded classrooms, inequality and lack of adequate ICT infrastructure to support teaching and learning (Jaffer et al., 2007). Also, despite some universities having deployed e-learning services, they are highly under-utilized due to problems such as unreliable electricity, slow Internet, low computer to student ration, limited digital literacy, resistance to use, and lack of pedagogical linkage with the available courses (Chitanana, Makaza, & Madzima, 2008; Mtebe & Kandoro, 2016). Therefore, the high mobile proliferation in the continent has prompted a significant number of research activities Porter et al.(2016) to identify ways in which these devices can be leveraged to support learning in the continent.

Apart from the Nokia and Microsoft MoMath projects in South Africa, a handful of studies have been conducted specifically for Africa. For example, Mtebe & Raisamo (2014)′s work at the University of Dar Es Salaam revealed positive students behavioural intentions to use mobiles for the learning activities due to their perceived ease of use and media efficacy. Also, Chambo et al. (2013)′s work on mobile access and deployment in secondary schools in Tanzania revealed positive possibilities of learning through mobile because the majority of students and teachers possess devices and know-how to operate devices. Similarly, it was revealed in other studies that the majority of African students use mobiles and other ICTs to access learning resources online (Duncan-Howell & Lee, 2007; Jaffer et al., 2007). However, these studies failed to describe the sacrifices incurred by students to own and use these devices.

Furthermore, there have been a number of initiatives to enhance learning and teaching in Africa including the Eneza project in Kenya that offers learning opportunities to students and teachers across Africa through SMS, web and Android applications (Brown, 2003), the ShuleDirect in Tanzania that offers learning resources, quiz, past-paper reviews and discussion forums to the secondary school students and teachers through mobile and web-applications (shuledirect, 2017), and the mobile Moodle project at the University of Dar Es Salaam in Tanzania (Mtebe & Kandoro, 2016). Similarly, the Mfunzi project, collaboration between Mzumbe University and the University of Ghent offers location-based support services to Mzumbe students through an android mobile application (Stroeken et al., 2015). Students can receive scaled announcements about the events and communications of importance from the university and other enrolled community members. These initiatives

represent a handful of similar initiatives across the continent that offers footprints of the m-learning success. It can be inferred that creative and well-thought m-learning initiatives help to improve learners' and teachers attitudes towards (Abu-Al-Aish, 2014). Although by this, we have not assumed that initial success can be easily sustained.

2.5 The Coming of Micro-learning

At the beginning of the chapter, it was indicated that micro-learning and m-learning are closely related. In this section, we describe the similarities and points of departure to improve understanding as well as establish the bases for our study of micro-learning deployment. Therefore, as it can be witnessed, the majority of the discussions in this section reflect on the topics and phenomena described while addressing m-learning. In order to avoid unnecessary repetitions, the only discussion of the topic is presented hereunder.

The best entry point to understanding micro-learning should be right at the junction between mobiles and m-learning. Despite some unquestionable m-learning potential, usability challenges (small screen size, low storage and processing capacities) of the mobiles and the software compatibility issues remain obstacles (*item 2 in figure-1*). Moreover, with the lack of standards for deploying m-learning services, there is no doubt that the majority of m-learning projects failed to fulfil the intended promises. Surely, mobiles are not primarily designed for learning purposes; they are intended for communication and interactive activities.

Micro-learning addresses these limitations. It is focused on creating standards that ensure learning with mobiles is ideal and convenient. This includes developing and delivering content and activities that satisfy learners regardless of their proximity, vicinity and devices in use. It is proven that delivering contents in long learning sequences and large chunks of information with low degrees of interactivity limits the potentials of m-learning (Kadhem, 2017). Thus, micro-learning content is organized into small "chunks" known as micro-units with a high degree of interaction and feedback to each activity. It is proven that learning in "small chunks" combined with well-designed micro-activities and feedback improves retention capacity and efficiency as described in the coming sections (Hug, 2005; Kadhem, 2017).

2.5.1 The Micro-Learning Concept

Research on micro-learning is still at its infancy stage; therefore, despite high attention paid to the new learning approach, there is no concise definition that is approved by the general

public. However, scholars describe micro-learning based on three main attributes: the size of the content, the duration it takes to complete a learning micro-unit, and the scope of the content (Bruck et al., 2012; Kadhem, 2017). It is widely accepted that micro-learning content should be simple and short to fit the size mobiles (Giurgiu, 2017; TalentCards, 2019). Also, the size of the content should be digestible and executable within a shorter duration to accommodate the low concentration rate and shifting spaces of modern learners. The scope of the content focuses on two aspects: simplicity and specificity; micro-units should address single learning objectives as well as focus on specific skill relevant to the learner (Sánchez-Alonso et al., 2006). Therefore, a single e-learning or m-learning topic is broken into several micro-units ("chunks") in order to fit the above descriptions.

Studies indicate that micro-learning is a natural attraction for the new generation of learners as it applies the rule of social media and the Internet. Since the invention of the web2.0 services, the online world is filled with applications that are known for short content. Social media platforms, including Twitter, Facebook, Instagram, youtube are among the popular platforms used by the majority that uses micro-contents. Also, it is revealed that short instructions are easy to absorb and interact with, hence yield the best results in terms of retention capacity (Kadhem, 2017). Also, *microcontents* as coined by Sánchez-Alonso et al., (2006) fits well with the ubiquitous devices that are the main learning device used by the majority "anywhere" and "anytime" (Smolle & Bruck, 2017).

Unlike m-learning, the micro-learning approach is controlled by the standard characteristics for course developers, instruction designers, and quality controllers to observe. These characteristics, also known as dimensions, contribute to the success or failure of micro-learning as they are associated with learning experience from learners' perspectives. In the pursuit to define micro-learning, Hug (2005) proposed a framework to appropriately describe, analyze or generate versions of micro-learning through seven dimensions which forms the basis for the majority of micro-learning discourses today:

- **Time:** relatively short effort, operating expense, degree of time consumption, measurable time, subjective time, etc.
- **Content:** small or very small units, narrow topics, rather simplex issues, etc.
- **Curriculum:** part of the curricular setting, parts of modules, elements of informal learning, etc. • Form: fragments, facets, episodes, knowledge 'nuggets', skill elements, etc.

- **Process:** separate, concomitant or actual, situated or integrated activities, iterative method, attention management, and awareness (getting into or being in a process).
- **Mediality:** face-to-face, mono-media vs. multi-media, (inter-)mediated, information objects or learning objects, symbolic value and cultural capital. In fact, it should be possible to integrate (blend) micro-learning approach with other approaches (Aigerim & Azamat, 2014; Polasek & Javorcik, 2019).
- **Learning type:** repetitive, activist, reflective, pragmatist, conceptionalist, constructivist, connectivist, behaviourist, learning by example, task or exercise, goal or problem-oriented, „along the way", action learning, classroom learning, corporate learning, and conscious vs. unconscious.

Although micro-learning appears to have emerged two decades ago, history suggests otherwise; the pedagogical value of learning through short contents was first introduced more than half a century ago in 1960s as "micro-teaching" (Hug, 2005). In micro-teaching, it was suggested that students learn better when they are not overloaded by information because the working memory of an individual is limited in term of size. The only improvement done to the micro-teaching that gave birth to micro-learning is the role of technological affordances. What makes micro-learning more useful and relevant in various situations is its ability to use mobiles to leverage from various learning resources available in several formats including audio, video, texts as well as images. Based on the nature of the content to be delivered, there are options to create video, audio, infographics, simulations, GIFs and more that can be either standalone or blended with other learning approaches such as e-learning, m-learning or traditional classrooms. The key to success lies in how well the course is designed to deliver the intended content and activities.

2.5.2 Advantages of Micro-learning

As discussed in the preceding sections, micro-learning is gaining a wider recognition on a daily basis by the academic and research institutions as well as cooperations. Micro-learning is used as the desired approach in providing professional developments in several organizations just because of its relatively easy way to absorb but also because the majority of the working generations have mobiles and are accustomed to learning on their own. Hence through micro-learning, it is possible to simulate how to perform a task or to follow routine procedures in the organization. Similarly, micro-learning has proven to work well in academic institutions at all levels. Previous research indicates that a well designed and

delivered micro-learning course coupled with immediate feedbacks improves learners' progress and productivity. Other benefits are:

i. It improves learning productivity. Due to the high retention rate attributed to the micro-learning especially when applied to the workplace, it makes it easy for the learner to practice and improve their work. Also, simulations and feedbacks improve the performance of learners and educators.

   Similarly, because the design of micro-learning is specific and skill-based, it is, therefore, ideal for imparting skills to learners in accordance with their needs. On top of that, micro-learning has a higher completion rate due to the simplicity and small size in such a way that learners are not disconnected with the content while engaged with it. Also, because of its prime tendency to be designed for mobiles, the majority of learners are able to access learning content anywhere and anytime (Kadhem, 2017).

ii. Micro-learning courses save cost and time. Traditionally, for employees who wanted to improve skills, it was necessary for the organization to prepare a learning session within or outside the organization (TalentCards, 2019). Both options not only cost fortunes of money from the organization but also employees' time. Similarly, the majority of these training is overloaded with irrelevant details not useful to the employee. Micro-learning is self-directing hence, employees at their own time and resources connect to the learning contents that are relevant to their career gaps. The only cost to the organization is associated with designing, developing, deploying as well as marketing the contents. As a result, the approach guarantees the filling of skill gaps within the organization.

iii. Micro-learning approach is very flexibly integrative. Unlike e-learning, micro-learning sessions can be designed as complementary materials to other learning approaches. Even for complex topics, they can be modelled in such a way that some concepts are run using a deep learning approach, while other aspects can utilize micro-based simulation and quizzes to increase the flavour to the learning experience. Besides, micro-learning units are specific and independent in such a way that they can exist by themselves. The decision to what approach to use depends on the type of the content, design of the course as well as profiles of the learners. For the micro-learning to succeed depends on having competent learners, able to navigate the Internet and synthesize the content on their own.

iv. Micro-learning approach is social and relevant for modern learners. As described before, modern learners and employees are acquitted with modern ways of doing things. Specifically, modern learners form a great portion of the network society. They are the

people who live next to their mobiles and always partake of social media. Micro-learning fits well with the style of the learners in terms of access as well as participation (Bruck et al., 2012). They are part of knowledge construction communities. Learners can choose what and when to learn as well as the order to follow. Also, it allows learners and issuers of content to collaborate for the sake of exchanging and improving knowledge and skills.

2.5.3 Micro-learning Applications

Since its inception, micro-learning has attracted the interest of different stakeholders from various fields not just to study its effect but to leverage from the business perspectives. Not only that it is used by organizations to save and generate revenue out of it, but also software developers have come up with several applications, software for specific purpose that support micro-learning deployments (Pappas, 2018). These platforms not only allow instruction designers to create and manage micro-units but also some are the gateways for learners to access the contents. They offer tools for creating and publishing content, tools for establishing and managing collaborations, tools for gathering and analyzing progress and continuity of the courses as well as offering instant feedback and integrity checkups. These platforms can be categorized in cloud-based applications, mobile apps, as well as standalone applications. Also, while some of the platforms are mainly free and open-source, the majority of the platforms are proprietary in such a way that the need for a license to use the platform is mandatory. Similarly, they can be grouped based on what they offer to the client; some of the platforms are specific to a particular field, and some are generic that offers just tools necessary for creating a micro-learning experience in whatever field one is interested.

At the top of mobile apps, we find applications such as:

- Duolingo, which offers language learning possibilities. By the aid of Duolingo, it is proven that one can improve the ability to learn new languages in the shortest time (Ahmed, 2016).
- Highbrow offers free bite-sized email courses delivery to a learner’s inbox every morning for ten days to finish the course in an art or science subject.
- Corbie offers quick and easy to digest emails teaching on subjects like art, science, and history each morning. Each lesson is designed to boost learner's knowledge in 5 minutes or less. Further,
- Easy-Ten is an app to learn any language with ten words a day. Generally, it is proven that learning through apps is both progressive and challenging; there are aspects of the

apps that improve learners' attention and motivation whereas other skills and knowledge are more complex to for the software to handle (Bogdan, 2016).

Apart from mobile apps, web-based, as well as cloud-based services exist. They include platforms such as TalentCards, mLevel, HandyTrain, Skill-Pill, Gnowbe, Grovo, SpeechMe and OttoLearn, just to name a few. These platforms offer various functionalities suitable for creating, monitoring and publishing micro-learning content. Unfortunately, the decision-making process on what platform to use is not an automatic process; it requires expert knowledge as well as understanding the demography of the learners and the profile including understanding the pedagogical value as well as strategic fit in the institution as a whole. Indeed, there is limited information on how to approach such a decision-making process.

The existence of the micro-learning-based apps and platforms confirm a new trend, a shift of focus from traditional LMS to more portable and mobile-friendly learning platforms. Similarly, it suggests that learning is becoming more personalized and social that challenges the well-established tradition that learning has to happen in schools and colleges, especially within the walls of classrooms. While it is acceptable that learning through micro-learning platforms is possible, such claim cannot be generalized in every context. Still, the contextual factors play a significant role in shaping the outcome of the training. Therefore, it is ideal to study such phenomena in every situation independently. Primarily, it is crucial to explore how micro-learning services are deployed and configured. Our study focuses on how micro-learning services are deployed in the higher education institutions in Tanzania by using a brokerage service (Ujuzi app) as the case, and we present the results in the coming chapters.

2.5.4 Micro-learning Problems

As it is indicated above, the micro-learning approach is developing, not yet established. Despite high popularity, micro-learning lacks frameworks and models that explain how it can be deployed in various settings, including higher education institutions. Similarly, the existence of a multitude of micro-units within an already crowded Internet make it harder for learners to navigate and connect all necessary components of the learning (Bruck et al., 2012; Polasek & Javorcik, 2019). The rule of the Internet is that each micro-unit is assigned a specific, complete and independent Universal Resource Locator (URL). This triggers the strategic decision-making process, especially on hosting of micro-units, security, access as well as quality. Further, while it is widely accepted that micro-learning can be integrated with

various learning approaches within learning institutions, little is known on how such integration should happen in terms of organization, design and development of the course for the sake of enhancing quality (Sánchez-Alonso et al., 2006; TalentCards, 2019).

Similarly, micro-learning approach lacks guidance in regard to the creation and hosting of micro-learning content. Experience shows that there is not one established approach based on research regarding platforms to be used. Some issuers take advantage of mobiles, and thus, they design mobile apps that are capable of issuing micro-units directly through the OS of the host device (Aigerim & Azamat, 2014). Other approaches include using a traditional learning management system (LMS) such as Moodle, Canvas, EdModo to create and store the contents (Polasek & Javorcik, 2019; Smolle & Bruck, 2017). The existence of alternative approaches contributes to the decision-making puzzles to instruction designers, course developers, as well as decision-makers. Unfortunately, learners are not involved in the decision-making processes.

Further, micro-learning is faced with the issues inherited from the m-learning era: the lack of interoperability of technologies; mobile-based applications are platform-dependent; as described before, applications deployed for one platform (OS) cannot operate on other OS. This affects accessibility as well as productivity. The decisions made at this stage affect the work of learners as well as educators. The work is likely to be unfruitful if the decision is made without understanding the social demography of the learners as related to the devices they own. Such an effect will be quiet apparent especially if the mode of delivery requires learners to use their own devices.

The existence of the identified problems as well as the lack of literature on micro-learning deployment in the East African context suggest that there is a need for more studies on how to enrich the communities with knowledge. Hence, this dissertation explores the phenomena related to micro-learning deployment in higher education institutions in Tanzania and suggests means and ways of improving it. Unfortunately, mobiles are the fundamental part of micro-learning success, no micro-learning outside e-learning context (Hug, 2005; Sánchez-Alonso et al., 2006).

2.5.5 Micro-learning Deployment

Because deployment of micro-learning is the prime focus of this study, it is crucial that we provide a concise description of the term “deployment” with the impetus to clarify how it is

used in the context of this work. While it appears to be a familiar term, it is applied differently in different fields. Our combined search of the Internet and English dictionaries suggests that the term is commonly used in the Information and Communication Technology (ICT) and military fields with a slightly different meaning. According to the Oxford English Dictionary, the term deployment refers to first: "The movement of troops or equipment to a place or position for military action". Second: "The action of bringing resources into effective action". The former seems irrelevant here, yet can serve as metaphor. Processes and activities that militaries across the globe undertake ensure that the right numbers of persons, as well as equipment, are strategically and tactically positioned in the right locations ready for engagement when needed. As previously described, the nature and extent of deployment depend on the available information concerning the task ahead. The general description fits the expression in our field: *'the rapid deployment of high-speed cable Internet services to consumers'* (Oxford, 2018). Despite the contextual difference, we may assume that the semantics and the ultimate goals of any deployment resemble each other to succeed in the undertaking.

Further, the term deployment is used differently within the ICT field. For example, when applied within software and application development, it refers to the post-development activities such as installation or implementation of software into the customer's site environments. It involves reconfiguring systems' or application-variables from the developers' into client's parameters, testing and handing over the application. Also, when used by network administrators, deployment means installing network infrastructure rather than single equipment to the clients or organization — for example, the deployment of VLIRUOS wireless infrastructure at Mzumbe University.

On the other hand, the act of pushing an antivirus or software client agent from the centralized server to a client computer is also referred to as deployment. Likewise, the act of publishing web-based or mobile-based application to users to apply to their activities is referred to as deployment. Hence, conscious of the diverse use of the term "deployment", the successive paragraphs provide a contextualized description of the term as it is used in this work.

Learning from the descriptions, the following can be deduced: First, deployment is a visionary, goal-oriented as well as pre-calculated process. It can be argued that whatever field wherein deployment is carried out, prior analysis of the situation is crucial. Deployment agents collect essential facts about the situation, analyze details, design and decide on the alternative options, mobilize resources before the actual deployment is conducted. For

example, ICT based deployment would require understanding the motives and justification for deployment, availability of necessary resources including budget, infrastructure as well as profiles of users that will participate in the operating the systems once are deployed. Secondly, deployment consists of multi-role, multi-function, as well as multi-level activities. Third, deployments are circumstantial as well as contextual in nature. Therefore, each deployment requires a specific approach relevant to the underlying context. While there may exist theories that predict user behaviours about the adoption or acceptance of the technologies, such predictions should concern the actual phenomena. For the deployment of social services such as micro-learning, stakeholders' involvement is crucial. Although deployment is distinct from acceptance and adoption, they are highly related. The ultimate aim of deploying a system is to improve situations of use. Therefore, understanding users' perception, attitude and motivation towards services are paramount.

Hence, in this work, deployment refers to the set of activities that lead to the implementation and use of technological systems. Specifically, we view technological systems as a set of different sub-systems that together accomplish a certain target(s). For example, an act of giving mobile devices to students alone cannot be regarded as deployment. Therefore, by deployment activities, we include pre and post-implementation activities that together ensure the system operates as required. They include activities such as situation and requirement analysis, capacity building as well as recruitment and policy formulations provided that the ultimate goal is to ensure the result of micro-learning deployment.

Our focus is, therefore, a micro-learning deployment model for higher education institutions in Tanzania that addresses both technical and non-technical processes. Our approach is shaped by the belief that in order for technologies to used and bear intended results, they must be value- and design-relevant. That means they should fulfil the needs of the society as well as they should be designed to fit the devices of the users as well as be easy to use.

2.5.6 Micro-learning Deployment Models

Deployment, acceptance and adoption of ICT technologies can hardly be studied without considering the generic models and theories underlying them. The Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), the Diffusion of Innovation Theory (DOI), and the Unified Theory of Acceptance and Use of Technology (UTAUT) are amongst the most seminal. By lack of an exclusive model tailored towards micro-learning, and due to significant inter-relatedness between micro-learning and m-learning, we compare m-learning researches in terms of their deployment models and approaches.

M-learning and micro-learning scholars across the globe are constantly contextualizing and developing models concerning micro-learning deployment in various settings. For example, Muyinda et al.(2010) propose a novel model for deploying mobile-based services in developing countries. Because of the lack of adequate infrastructural resources and technologies, the mLearning Objects Deployment and Utilization Model (MoLODUM) offers learning experiences based on contextual parameters of the learner. The model contains a special-object class to identify learner's context before rendering services. For example, in order to deploy the learning content or support to the specific learner, the "MobileLearningObject" class determines appropriate media type and format that fits the learners' devices, pedagogical requirements and skills, the network capacity as well as guiding policies in the region. Thus, through the use of MobileLearningBroker class in association with other classes such as MobileLearningobjectUser and the ConnectivityProfiler algorithms and software, specific interactions are provided to learners in accordance with their context.

While we appreciate the novelty of the model, especially as it addresses the diversity and complexity of devices, users and media types, it fails to provide directions on how user, devices and networks are profiled. For example, it does not reveal what, how and when user-related data are captured, stored and processed to achieve the results. Also, the module does not explain how the constructs interact with actual situations such as institutional policies, individual challenges, as well as other contextual challenges facing the stakeholders. Further, it does not provide strategies necessary for deploying and embedding pedagogy into m-learning before deploying into a specific context. In addition, although the case was developed for Makerere University, it does not explicitly declare the level of education to which the model is intended to be used.

Another case concerns the m-learning model for secondary schools in Tanzania proposed by Chambo et al.(2013) presenting important factors for successful m-learning implementation. It emphasizes the availability of enabling technologies to guarantee connectivity, coverage and quality of services, ability to integrate pedagogically sound content and activities, and availability of economically sound services to schools, students as well as teachers. According to the authors, education stakeholders will only be satisfied if the situations concerning technology, pedagogy and their associated cost are appropriate. Furthermore, once users are satisfied, likely they can achieve the intended learning outcome (Chambo et al., 2013).

However, the model is limited to the m-learning implementation in pre-university level even though the underlying infrastructure for mobile network services in the country are the same in all levels of education. Mobiles are used much more to communicate and access learning resources in higher education institutions than in pre-university levels. Also, the model fails to account for the role of institutions as stakeholders in shaping the learning environments. We argue that national and institutional policies play important roles in technology-mediated learning implementation. Furthermore, there are no guidelines on how the identified components should be integrated to satisfy the learners for the sake of yielding the intended objectives.

Next, Brown (2005)′s model for m-learning in Africa is an ideal reflection of what m-learning represents in the continent. It prescribes the possibilities that m-learning can provide within the spectrum of available technologies. Also, it describes the scope of m-learning: the access to learning resources, schedules and assessments or communication services like administrative services such as school fees payment, announcements and other services that previously would be done through e-mails. Further, it asserts that it is essential for the learning institutions to establish suitable learning conditions to the learners.

While the focus of the model to extend e-learning services to regions known for poor infrastructure is ideal, the lack of consideration for micro-learning deprives learners from benefiting from these services, especially learners with low ICT skills and quality devices. Further, as acknowledged by the author, the model is rigid to accommodate advances in technology (Brown, 2005). An application conceived so as to be open to social innovation is a major challenge. Moreover, the model fails to recognize the importance of stakeholders, including learners and teachers in the design and deployment process. Also, it does not explain how different elements converge to form one functional unit.

These deficiencies have been purposively dealt within our work. We provide a critical explanation of how to succeed in the deployment processes. We follow Barker, Krull, & Mallinson (2005) in proposing a theoretical model for m-learning adoption in developing countries that outlines the key elements necessary for influencing m-learning uptake within the institutions. They include the availability of infrastructure, technologies, policies and guidance. Also, stakeholders' involvement during the planning and designing of m-learning services is crucial.

On top of that, success factors include coordination, interactivity, communication, collaboration as well as mobility and negotiations. Unfortunately, it is not clear what these

exactly mean in every learning environment, since the mobile learners are believed to be dynamic. For example, there is no explanation of how these roles can be applied.

Moreover, the model is narrowly focused; it fails to identify a broader spectrum of stakeholders. For example, it ignores governments that are in charge of setting policies and controls over academic institutions. Also, the scope is limited to the institutions and ignoring distant learners whose environment is not well connected through wired and wireless services. As acknowledgement by the authors on the possibility of future research to focus on investigating the guidelines and policies that need to be in place (Barker et al., 2005). Moreover, in analyzing the technical capabilities of different wireless technologies, and determining their suitability to an m-learning environment, much is needed to extend the model to fit the needed contextual situations of Tanzania higher education institutions.

Also, the use of activity theory in designing m-learning environments is championed by (Uden, 2006). It is argued that Activity Theory offers the needed flexibility to explore the activities and the subsequent contextual elements that affects learning experiences. If what Traxler & Kukulska-Hulme (2016) and Uden (2006) claim is true, the m-learning designs that ignore learner's contexts fail to achieve the primary goal of mobile-based learning: to address the learners' mobility and their ever-changing contexts. In order to design the m-learning environment and applications, both social, cultural, political and technological variables and their respective interactions with the environment need to be taken into account to avoid unnecessary contradictions. Therefore, the designs should reflect the underlying tools, rules and procedures, division of labor, as well as communication ties that interact with the subject (learner/institution) to achieve the intended objectives. On top of that, the framework provides a detailed description of the process needed to perform the design work.

The proposed activity theory is known for being a useful approach in analyzing complex systems, especially to understand the interactions between different elements. However, its application in m-learning and micro-learning design and deployment fall short in the following aspects. First, it just offers a model for analysis and no prescription of how the mobile-based learning services should be deployed. Secondly, although the theory supports multi-level assimilation, it does not guide on how the cascaded outlook (multi-level view) of the systems can be integrated into multi-level designs.

Next, to address the need for mobile-based learning models in higher education, Abu-Al-Aish (2014) proposes an analytical model for deploying and sustaining m-learning services. According to him, m-learning deployment suffers from several serious challenges, including the high cost of devices, unreliable Internet connectivity, usability challenges due to limited

device capacities. Also, the lack of digital awareness to students, management teams and teachers prevent institutions from achieving the intended outcomes. The majority of m-learning project initiations are not sustainable due to lack of resources, lack of commitment from stakeholders, resistance, and being deficient in a control mechanism to monitor progress (Abu-Al-Aish, 2014). The proposed model consists of pre- and post-deployment requirements essential for deploying and sustaining deployment, as explained below.

During the pre-deployment stage, institutions deal with the provision of cost-effective solutions, creating awareness to students and lecturers, availability of suitable mobile devices, Internet as well as compatible m-learning applications that meet user needs. Upon successful implementation, in order to sustain the deployed services, it is essential to ensure that the post-deployment sustainability cycle is attended. The cycle deals with conducting teaching usability assessments, instilling trust and confidence, training users and teachers, tracking resistance as well as establishing and maintaining quality controls. Although not explicitly stated, it can be inferred that the success of m-learning deployment rests on the readiness and commitment of the institutions to strategize, commit necessary resources as well as to empower stakeholders towards the right cause.

The availability of models like this that target higher learning education is an ideal factor to influence the decisions making processes. Especially, the one discussed above highlights the importance of addressing sustainability issues that are rarely found in the other models. However, the overall target of the model is limited to the internal institutional issues that happen before and after deployment. It offers no guidance on how actual deployment should be carried. Also, the model fails to highlight the interactions that exist between elements that are internal to the institution and those that are external. Even though it explicitly states that the focus is to extend the institutional e-learning capabilities, the model ignores the possibility of learning taking place outside universities where the learning institutions do not control infrastructure and policies.

2.5.7 Alternative Theories and Models

Alternatively, if one chooses to approach micro-learning deployment from an information systems point of view, there are prominent theories and models available, influenced by behavioural sciences research fields. These theories help to explain behavioural characteristics and tendencies of individuals when it comes to technology adoption. Adoption and utilization of technologies are essential to successful deployment. Theories are instrumental in explaining issues that drive individuals to try and later adopt technologies.

Further, they are useful in setting strategies that can be applied to stimulate individuals' desire to use certain innovations of technology. Because the purpose of any systems deployment is to make it used, lessons and constructs obtained from these theories are useful and inform our study. In the coming paragraphs, we present our critical review of three currently seminal theories: the Technology Acceptance Model (TAM), the Diffusion of Innovation (DoI) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Further, we explore how useful these theories might be for our project.

2.5.7.1 Diffusion of Innovation (DoI)

Conscious of understanding what makes some ideas, innovations or technologies get adopted faster than the others, Rogers developed the DoI to explain and predict people's reaction to innovations (Rogers, 2002). Based on empirical evidence, he claims that the speed with which innovation is adopted by members of specific social systems is affected by how key members in the community perceive such innovation in terms of its usefulness and ease of use (Al-Jabri & Sohail, 2012). Based on belief (not actual values), if the innovation or idea is perceived to be useful, such as adding value to the current situation, the innovation will likely get adopted faster than others (Dibra, 2015). Likewise, if a certain innovation is perceived to be easy to use, requiring minimum effort, then it will likely be adopted faster than the hard to use competitor. To clarify these factors, Rogers presents five attributes that explain and predict the adoption rate of any innovation: relative advantage, compatibility, trialability, complexity and observability (Rogers, 2002).

Relative advantage is defined as the degree to which an innovation is perceived as being more valuable than its predecessor in terms of profitability, social impact as well as functionalities or other characteristics. For example, personal computers are perceived to be more valuable compared to typewriters because they can do more than just typing; they have additional features for storing and formatting documents. For that case, an innovation with higher ratings in terms of relative advantage will likely be adopted faster. Next, compatibility refers to the degree to which an innovation or technology is perceived to be consistent with the existing values, past experiences and needs of the potential adopters (Rogers, 2002). The degree to which an innovation is perceived to deviate from the known philosophies, standards or experiences affects the adoption rates positively or negatively. For example, changing from traditional teaching and learning approaches to technology-mediated learning represents a shift. Hence it requires a significant amount of time, effort and dedication in order to make

it happen. Likewise, if the innovation is perceived to be hard to understand or use (complexity) or hard to experiment with (trial-ability) it will be slower in being adopted.

Furthermore, the degree to which an innovation's results are visible to others can easily attract people to adopt. For example, social media to some extent spread in function of the visibility of their results, namely the messages. A group member can easily feel what other members are experiencing through their participation in social media. DoI furthermore helps to explain the characteristics of the potential adopters of innovation. Evidence suggests that it is believed that when a new innovation is communicated, its adoption rate will follow a close to normal distribution in a Gauss curve (Dibra, 2015). According to DOI, five groups of users emerge during the adoption period: the innovators, the early adaptors, the early and late majorities, and the laggards. As soon as an innovation is released into a market, 2.5% of people will adopt it regardless of whether there is enough information or not. They are the innovators, always anxious to try new ideas or technologies. Then, after the information concerning the innovation and its relative advantages is shared, the early adopters (12.5%) join the adoption group. After the innovation is proven to be useful, the early majority (34%) and the late majority (34%) will follow respectively. Unfortunately, the laggards (16%) will only join the group after the technology has become obvious or there is an obligation to use (Rogers, 2002). It can be inferred that information and the communication media drives the diffusion process. The spread of messages concerning innovation as well as observable results from members of the social group is vital (Fichman, 1992).

DOI is one of the highly regarded theories in both behavioural and IS research due to its robustness and simplicity. It informs innovators and managers about issues of importance to adhere to during the design, development as well as deployment. When applied in research, it helps not only to explain and predict the results but also to formulate necessary variables to evaluate complex situations.

2.5.7.2 Technology Acceptance Model (TAM)

Unlike DOI, TAM was developed specifically to describe people's acceptance of information systems (IS). Despite the high cost and effort of deploying IS, they are widely known for being underutilized (Lee, Kozar, & Larsen, 2003). The TAM version of 1986 is regarded as highly robust and applicable by various scholars from different disciplines including health, e-banking, e-commerce, e-learning and tourism. Having adopted some constructs from the Theory of Reasoned Action (TRA), it relates technology acceptance to individuals' attitude. The original argument is that an individual's behavioural intention of using a given

technology will influence his or her decision. Particularly, an individual's behavioural intention to use a certain technology is influenced by two key constructs: perceived usefulness (PU) and perceived ease of use (PEOU). The PU is defined as a degree to which the technology fulfils, improves or simplifies one job performance. The PEOU refers to the effort needed to operate, apply, understand or use technology.

Grounded in empirical evidence, scholars regard TAM as the most applied theory on technology acceptance due to its robustness, simplicity and power to determine and explain acceptance and resistance. Due to its simplicity and flexibility, various scholars have modified the original version by adding more variables. New constructs such as subjective norms, job experience and image help to explain their impact on belief and attitude. TAM2 represents the most valuable and recognizable contribution as it expands our understanding of factors that contribute to individual belief (Lee et al., 2003). Of the two main factors, the perceived usefulness is proven to be the most significant in determining an individual's attitude. Hence, if the technology is perceived negatively on its value addition, it will likely not be accepted despite having more intuitive features than the alternative scenario.

Both the original and revised versions of TAM provide anchorage to our work. Deployment strategies cannot ignore factors that explain and affect adoption and usage. Collectively, we take into account the need to specify functionalities that trigger people's interest to use technologies.

Despite the novelty of TAM, it is criticized by scholars for its simplicity and lack of depth (Ajibade, 2018). It is not useful enough to explain, for example, what makes technology easy to use or to be useful. Also, it relies on perceptions instead of actual usage. Hence, it makes its findings hard to explain; they become mere predictions. Micro-learning deployment into higher education institutions requires an understanding of the prevailing social-technical situations available at the sites. This lack of social explanation and attention to interactions makes it less suitable for exploring micro-learning deployment in the universities as required by our study.

2.5.7.3 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology resulted from evaluating, mapping and integrating constructs from eight influential IS theories including TAM, TRA, DOI and the Theory of Planned Behavior (TPB) (Venkatesh et al., 2003). Similar constructs across the identified theories are merged into the new theory in order to simplify the process

of choosing an appropriate theory to explain and predict adoption and use of technologies (Venkatesh et al., 2003). The original version of the UTAUT consists of four factors and four mediating conditions that influence an individual's behavioural intention to use technology. It postulates that the behavioural intention to use any technology is influenced by the performance expectancy, effort expectancy, social influence as well as facilitating condition. The performance and effort expectancies are mapped from TAM's perceived usefulness and ease of use, respectively. The social influence refers to the degree to which a person perceives that important others believe that he or she must adopt a method or system (Im, Hong, & Kang, 2011). Also, facilitating conditions are based on the perception that the organizational and technical infrastructure such as policies and systems are in place to help users to achieve their objectives.

Literature reveals that the application of UTAUT in IS research has been rampant. However, very few scholars have applied it in its original form. The majority have revised its first version of 2003 by adding or modifying the constructs and mediating factors. Despite the modifications, the performance expectancy construct remained relevant as a determinant of behavioural intention to use a technology in most contexts (Venkatesh et al., 2003).

In contrast, other variables significantly vary from one situation to another. According to Adams (2006), culture and cost of technologies are such important constructs that need to be included in the original model especially to explain the value of culture for social influence as well as attitude. Other variables such as age, experience and voluntariness play a role.

Just like the previous theories, UTAUT provides important variables as well as highlights important strategic consideration suitable for explaining not only adoption but also deployment. It profiles users' needs based on their contextual phenomena. Unfortunately, it inherits the limitations of the quantitative approach. Thus, it is limited when it comes to providing a satisfactory explanation of the situation. We concur with (Lee et al., 2003) that adoption and deployment go beyond individuals' rational decisions and predictions. There is a need to value the organizational and social-cultural interactions.

Furthermore, UTAUT relies on self-reported performance rather than actual performances. To design and deploy micro-learning services in any context relies on the understanding of the situation and requirements that unfortunately cannot be addressed by the UTAUT.

Generally, the described theories implicitly perceive and approach mobile-based learning deployment adopting an instrumentalist point of view. Their approach is shaped by the belief that technologies are just tools that can be applied equally to achieve any means. Also, they ignore the existence of other theories and principals that contradict with the adoption

principles. For example, in education, what is important is not just adoption, but adoption that fits and addresses pedagogical expectations (Jaffer et al., 2007). To realize such requirements, designers and developers of the technologies have to collect and analyze data about the context to which the solution responds.

Specifically, by ignoring the theoretical perspectives related to learning limits the ability to envision the pedagogical value of micro-learning deployment in higher education institutions in Tanzania. For example, it is impossible to measure the success of technological deployment in education settings without consulting learning theories including the Connectivism. Therefore, we opt for an approach that engages stakeholders in determining relevancy and rigour of the proposed solutions in the processes of exploring, explaining and developing the deployment models and strategies for micro-learning in higher education institutions. The concluding sections propose a viable and verifiable approach.

2.6 Theoretical Framework for the Study

Unlike other technological deployments in organizations, micro-learning represents more than just a technological deployment into the learning context. While technology constitutes the interface that learners and teachers use to achieve their learning goals, scholars consider pedagogy to be essential in ensuring learning to produce the anticipated values (Brown, 2005; Kukulska-Hulme & Traxler, 2005; Roberts et al., 2015). Both technology and pedagogy combine to provide a learning experience that conforms to the social context specific to the learner. Such revelations influenced our decision to approach the study by looking through three lenses: the Critical Theory of Technology, the Design Science Research, and the learning theory of the digital age – Connectivism. We view deployment as a democratic process that necessitates multi-sector and multi-level participation of all actors. The technocrats are responsible for translating the social requirements from stakeholders into relevant, actionable and programmable artefacts used by the stakeholders to accomplish the specific social task.

2.6.1 Critical Theory of Technology (CTT)

The Critical Theory of Technology was founded by (Feenberg, 2005). Conscious of the prevalent criticism from the members of the Frankfurt school including Heidegger and Marcuse on the dominative and oppressive power of modern technologies, CTT provides an alternative understanding of the power relations between technologies and societies. Specifically, it refutes claims that technologies are either neutral or autonomous. In order to

understand the true nature of technology, Feenberg (2005) proposes two levels of analysis that help to de-contextualize technologies: the primary and the secondary levels. While the primary level represents affordances assembled in the devices, the secondary level deals with technical codes that make technical-designs and implementation. Significantly, the affordances reflect the interest of the dominating groups in the social debate. If this is true, it is impossible to achieve total neutrality in technologies because they inherit some form of implicit bias embedded in their design. For example, a mobile phone is biased to those who have functional eyes and ears. Similarly, staircases are biased against people with disabilities (Allen-Brown & Nichols, 2004; Schmid, 2006). This is because the designers and the political decision-makers are only interested in making profits from the majority groups consuming in society.

Determinists believe that technologies intrinsically contain power to influence the way people employ them. The dominant political regimes and capitalists decide about their benefits without being able to change the designs. For example, in order to maximize profit and to improve production in the modern organization, ICT equipments are deployed, but they bring instabilities in society. Some technologies such as televisions empower the dominant groups by imposing their ways and styles through controlled content. Other technologies destroy social values and are unethical. The introduction of computers and other ICTs create unemployment and job misfits for many individuals. These are examples of intrusive effects of technologies into societies as claimed by the determinists.

However, constructivists refute such claims by suggesting that technologies can be re-shaped by societies to reduce or improve the social situation through political and legal processes. If societies discover misfortunes, irregularities or setbacks as a result of applying technology, they have the power to institute change in the design and techno-codes through protest or resistance (Feenberg, 2005). For example, if claims that mobile phones, rather than empowering students and teachers, distract or cause illegal and unethical practices among students, they can be regulated. Policies and regulations, as well as awareness campaigns, can be established and enforced to eradicate the problems.

CTT fits well within our study because of the influence it brings particularly in aligning technical designs with social problems. Also, it emphasizes the democratization of the designing process to avoid damaging consequences. Even in education, technology deployment needs to involve stakeholders and to address imminent social problems to avoid resistance and protest from teachers and students.

Also, as we refute the claim that technology is universal, we argue that not all technologies are universal. It is possible to disassemble and reverse-engineer some technologies into a different context (Miller & Costa, 2016). Such an undertaking requires collaborative work between technocrats and other stakeholders to ensure the relevance, safety and reliability.

Unfortunately, the Critical Theory of Technology falls short of a methodological approach to explain how technologies should be deployed in educational environments. Therefore, in order to fill the void, we combine it with Connectivism learning theory with its focus on deployment as explained below. We conform to the assertion that learning technologies must address specific aspects of pedagogy and processes that are essential for learning to happen, especially in the context of technology-mediated learning.

2.6.2 Connectivism – The Learning Theory of the Digital Age

As previously described, technologies are shaped by the socio-political contexts to which they are applied (Feenberg, 2005). If so, micro-learning technological implementation and use are subject to these underlying conditions of the environment. It is widely argued that the choice of the pedagogical approach influences the way courses, instructions and assessments are designed and developed. Importantly, choices made regarding learning theories influence other choices regarding teaching and learning experience such as the design and the delivery of content, activities as well as sources of materials (Dunaway, 2011; Kop & Hill, 2008).

For decades, educators have relied on different learning theories, including behaviourism, cognitive psychology, and constructivism to define and set learning environments for learners. Commonly, teachers in these environments control the learning processes (Dunaway, 2011; Kop & Hill, 2008). The advent of the Internet and related resources outweighs the ability of teachers to cope with the exponential growth of global knowledge (Siemens, 2014). Thus, Connectivism provides an alternative approach to learning and teaching in the digital era.

Principally, Connectivism is developed as the learning theory to leverage from the access to digital media, especially the Internet and web 2.0 services in education settings (Bell, 2011; Siemens, 2014). It stresses that unlike before, now learning is more socially mediated through technologies. Also, knowledge resides in more than just human brains. As Castells (2004) puts it about the network society, both human and non-human nodes are a significant part of the online transactions. The existence of massive and open databases, open access publications, online community blogs and forums as well as business intelligence software

means that learners no longer depend on the teachers in class (Dunaway, 2011; Siemens, 2014). Both teachers and students actively interact with technologies to search for specialized knowledge and information (Bell, 2011).

Further, with the high proliferation of mobile devices, learners no longer need to be in class for them to learn. Hence, Connectivism emphasizes taking advantage of the knowledge distributed across the Internet. Learners can benefit from the existing multi-level and multi-purpose learning resources, learning communities and expertise that can be exploited by the capable learners (Siemens, 2014). Thus, learning has become a network-forming process, learners are not limited to what they learn and access in their locality, the Internet is open to everyone.

A prerequisite to successful application of Connectivism lies in the learner's ability to traverse nodes, evaluate the sources and content, establish and maintain a connection as well as to synthesize materials from various sources (Bell, 2011). For Connectivism -based learning to occur radical changes need to happen in the way we theorize teaching and learning, set learning environments, as well as how we impart necessary skills to the learners. In particular, teachers' roles need to shift to reflect a student-centred approach. For example, instead of providing students with the content, teachers should impart skills to evaluate reliable sources, to synthesize contents so as to connect different concepts and ideas, as well as to participate in knowledge generation rather than being consumers (Dunaway, 2011).

Despite some ongoing discourses concerning the place of Connectivism in the education sector, we acknowledge its contribution in setting the vision of our project. It helps to define the ideal environment and settings for micro-learning. They include the required infrastructure, design of the course, activities as well as teachers attitude. Therefore, the setting of research instruments such as interview questions reflected the requirements and demands coming from Connectivism, especially those related to readiness and challenges (see figure-1).

In order to address the weaknesses of both Connectivism and CTT, the two theories are combined with the robust Design Science Research as described below.

2.6.3 Design Science Research (DSR)

DSR is an information systems (IS) research approach that acknowledges the contribution of the artistic and scientific processes of designing and developing socio-technical artefacts[4] that improve lives and business performances (March & Storey, 2008). Unlike other approaches, DSR focuses on the science of artefact building to extend the boundaries of the existing artefacts and the known solutions. Also, it is concerned with building new and innovative solutions that represent new possibilities (Hevner, 2007). The success of the artefact building process relies on the researcher's ability to identify unique and relevant social or business problems or opportunities and turn them into workable solutions (Gregor & Hevner, 2013). While artefact building is not new to the IS industry, the requirement to apply the existing theories during the identification, development and evaluation of the artefact differentiate it from the other. Both knowledge contribution and consumption are pivotal aspects in any DSR (Hevner, 2007). The figure 2-2 depicts the design science research approach.

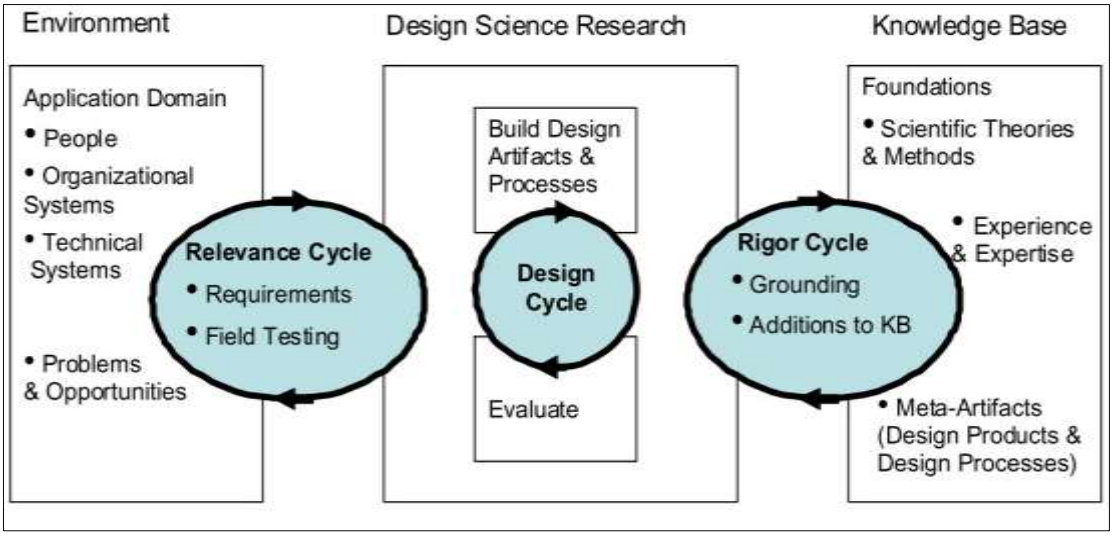

Figure 2-2: Design science research cycles as presented by (Hevner, 2007).

First, the DSR activities are performed in three important cycles: the relevance, design and rigor cycles as depicted in the figure above. The processes begin with the relevancy cycle whereby social or business environments are explored to identify important problems that require the development of new or an improved version of the existing artefacts. Alternatively, the process may start with the foreseen opportunities that require inventing new methods, constructs, models or software to advance the existing knowledge. In order to add value to the DSR projects, the identified phenomena need to be relevant to the respective environment. Also, the problem must be unique in such a way that it cannot be solved by

[4] Artifact as used in design science research are constructs, methods, models or instantiations (Hevner, March, Park, & Ram, 2004)

existing applications (Gregor & Hevner, 2013). As stressed by the critical theory of technology, the democratically identified problems, ethically proven and functionally fit artefacts, significantly improve situations (March & Storey, 2008). The relevancy cycle bridges the social and technical aspects of the artefact development process by providing the design team with relevant specifications as well as theories to be applied (Gregor & Hevner, 2013; Hevner, 2007).

Secondly, the design cycle is concerned with the design and development of artefacts based on the specifications (Hevner, 2007). It is an iterative process; artefacts are developed and evaluated by using appropriate rigorous evaluation methods as well as on-field evaluation to ascertain their contributions to the existing domain knowledge as well as societies. If the developed product fails the test, it is refined until the optimal solution is realized in terms of its relevance and rigour. As in the relevancy cycle, researchers are free to apply the established theories from other fields. Also, based on the feedback, researchers may opt to revisit design specifications or data-collection process to clarify and improve the output. It is acceptable to apply rigorous engineering and IS design and development approaches including the prototyping and systems development life cycle and others (Gregor & Hevner, 2013). The rigor cycle ensures that artefacts are developed in accordance with the established theories' design principles. Apart from the artefacts, the DSR produces and communicate knowledge about the artefacts in the form of publications.

The application of DSR, especially design science research methodology in the IS domain, has significantly increased for over two decades (Suero Montero & Kapinga, 2019). Despite being applied with minor variations, the fundamental principles of Design science Research remain unchanged. For example, Montero & Kapinga (2019) have applied DSR in the development of a mobile application to support rural women entrepreneurs in Tanzania. In their work, the emphasis is placed on two key constructs added to the original methodology: co-creation and co-design of artefacts. The two constructs call for the involvement of end-users (beneficiaries) during all three DSR cycles: relevancy, design and rigor. During the development of the mobile application, women entrepreneurs were part of the problem identification, requirement identification, artefact design and evaluation. It is argued that the involvement of the end-users into the development process promotes the sense of ownership that in turn raises usage and subsequently sustainability of the project (Suero Montero & Kapinga, 2019).

Smith & Turpin (2017) combined the DSR methodology with Activity Theory (*originally developed by the Russian psychologist Aleksei Leontiev in 1978)* in developing socially relevant ICT platform for elderly women in rural South Africa. They managed to use activity theory to uncover hidden socio-political voices from the women. The original DSR relies on the involvement of users in the overall development processes, but the approach implicitly ignored other voices that resonate from power dynamics occupying the environment to which the system is to be deployed. The women of Mafarafara were able to influence the design decisions and considerations while taking part in the development processes (Smith & Turpin, 2017). Hence, their participation influenced their desire to use the app and participate in further activities tailored to the project framework.

Likewise, the DSR approach is used during design, development and evaluation of mobile learning application for computer education (MobileEdu) for higher education institutions in Nigeria. The purpose of the application is to improve teacher-student engagements. The identified problem was the lack of interactions between students and teachers resonating from over-crowded classrooms, which is common in Africa (Isaacs & UNESCO, 2012). Through the application of DSR approach, the mobile application MobileEdu was developed to involve students and teachers through interviews, surveys, focus group discussions during all phases of DSR at the Madibbo Adama University of Technology Yola, Nigeria. The app is proven to have potential for addressing the intended problem (Oyelere, Suhonen, Wajiga, & Sutinen, 2018).

On top of that, DSR is emerging to guide decision support systems but also expert systems development researches (Arnott & Pervan, 2016; Miah & Genemo, 2016). Specifically, (Miah & Genemo, 2016) provide a critical account on the way DSR has been adopted into Experts Systems in the past decade. In his study, he successfully applied (Hevner, March, Park, & Ram, 2004)'s seven guidelines needed to apply DSR for artefact development and publication.

The above are a handful of examples that demonstrate the applicability and suitability of using DSR approach and methodologies in various contexts related to Information Systems deployment. These examples demonstrate the value of social inclusion into the design and development of the artefact advocated by the Critical Theory of Technology (Feenberg, 2005). The involvement of users in all the design phases shapes the artefact to address contextual issues as well as creating a sense of ownership among the wider user communities (Suero Montero & Kapinga, 2019). During the execution of the DSR methodology,

researchers are free to apply various data collection methods including survey, interviews, documentary reviews, focus group discussions, prototyping as well as other methods available. These approaches are applied in this work, as described in the coming paragraphs.

The application of the DSR approach in the present study helps to leverage from CTT and Connectivism learning theory. Both emphasize the involvement of social actors in shaping technologies. During the relevancy cycle, education stakeholders from four universities in Tanzania were involved in describing their contexts and requirements, which will appear relevant to Connectivism learning theory. Then the artefact design and development processes followed, as detailed in the methodology chapter. Our study concerns two types of artefacts: the micro-learning deployment model for HEIs in Tanzania and the mobile brokerage application (Ujuzi app) that support Connectivism -based micro-learning, as detailed in chapter 6. In order to respond to the rigour demands of the DSR, both artefacts and knowledge contribution are evaluated and grounded within established theories, as detailed in chapter 3 (Methodology). The design and development of the Ujuzi app followed all criteria of the methodological approach required by the DSR. The app was evaluated and used by students throughout the semester under the supervision of the researcher to identify its contribution in improving learning experiences as detailed in the result- and methodology-chapters.

2.7 Brokerage Services and the Rise of Digital Badges

The terms "broker" and "brokerage" commonly refer to intermediary entities that work for customers or investors in the business world. According to the Oxford Dictionary, brokerage is done by "a company that buys or sells goods or assets for clients" (Oxford, 2018). The terms are commonly used in the real estate and stock exchange industries to recognize the work of individuals or companies that are specialized in analyzing financial information and market trends before reacting to the available deals on behalf of the customers or investors (Ferreira, Spahr, Sunderman, Banaitis, & Ferreira, 2017). At the end of each successful deal, brokers receive payments in the name of commission. Besides, the invention of the Internet, especially the coming of e-commerce and e-services across all sectors has expanded our understanding of the term brokerage to include individuals as well as technologies that operate in intermediary to mediate interactions between two or more parties (Babatunde & Ajayi, 2018). However, the term is used with slight differences across other sectors including Information Technology, anthropology and public health.

In public health, the term brokerage is associated with "knowledge broker", the individuals, organizations, or companies with responsibility to translate evidence-based research knowledge to influence in policies, practice as well as products. The term was coined and highly researched and used in Canada (Dagenais, Laurendeau, & Briand-Lamarche, 2015; Dagenais, Somé, Boileau-Falardeau, McSween-Cadieux, & Ridde, 2015). Since its introduction, it has attracted a number of researchers trying to explore the applicability and the roles of knowledge brokers. In principle, knowledge brokers bridge the gaps that exist between knowledge producers (researchers) and users of knowledge, including end-users, practitioners as well as policymakers (Dagenais, Laurendeau, et al., 2015; Dobbins et al., 2009). Significantly, they are part of knowledge translation and exchange strategies aimed at improving public health practices across societies, nations as well as within organizations they are working with (Dagenais, Laurendeau, et al., 2015; Van Eerd et al., 2016). Unlike other forms of brokers, knowledge brokers have an important role and career within public health and have attracted recognition of the world health organization (Elueze, 2015; Van Eerd et al., 2016).

Several studies have been conducted regarding knowledge brokers (Chen, Li, Fan, Zhou, & Zhang, 2016; Elueze, 2015). Specifically, it is proven that knowledge brokers have an effect on the exchange of evidence-based public health knowledge to users and policymakers (Elueze, 2015). Regardless of whether one works as mediator, liaison, gatekeeper, coordinator or consultant, the value of what they do significantly contributes to the successful implementation and effective use of evidence-based knowledge by the intended audience (Dagenais, Somé, et al., 2015; Dobbins et al., 2009; Kislov, Hodgson, & Boaden, 2016). Also, although it is argued that the existence of knowledgeable professionals such as clinical professionals contributes to the success of the project, the reality is that knowledge brokering is a complex endeavour that requires a multi-disciplinary approach (Elueze, 2015; Kislov et al., 2016); it is impossible for an individual to possess all necessary expertise needed (Dagenais, Somé, et al., 2015). Also, like in any other knowledge exchange, the unseen side of knowledge brokering must be avoided by means of imparting skills and best practices to all stakeholders (Kislov, Wilson, & Boaden, 2017).

Likewise, when dealing with intercultural relations, cultural brokers are widely known for their role in shaping and mediating understanding and reducing conflict between people of different cultures (Salazar, 2014). The term was coined by anthropologists to recognize the work of individuals who played the intermediary, mediator, culture translator between colonial governments and the societies they ruled (de Jong, 2016). Cultural brokers leverage

from their extensive understanding of two or more languages and cultural values to bridge communication and understanding gaps between strangers (Uimonen, 2012). Confronted with unfamiliar situations in their field sites, anthropologists have always relied on the aid of native informants to navigate through (de Jong, 2016; Uimonen, 2012). Till date, with the immigration crisis across the globe, the existence of cultural brokers in various fields such as health, immigration and police, human right activists play a crucial role (Hodge, Cadogan, Itty, Williams, & Finney, 2016). They facilitate and mediate social integration and quality of services (Hodge et al., 2016; Salazar, 2014).

Similarly, brokerage services are essential not only in the physical world but also in the online world. To effectively serve customers with relevant cloud-based services, companies rely on brokerage services (Abdollahzadegan, Hussin, Razak, Moshfegh Gohary, & Amini, 2013; Yangui, Marshall, Laisne, & Tata, 2014). It is apparent that there are several providers of cloud-based services offering varying degrees of affordances (Pawluk, Simmons, Smit, Litoiu, & Mankovski, 2012). Just as when the anthropologists enter new territory, customers are faced with varying degrees of uncertainty in choosing comparatively optimal services (Pawluk et al., 2012). To address such uncertainty, a number of cloud broker applications and frameworks are deployed to help to bridge the navigation gap. Such services include CompatibleOne, STRATOS and "Cloud Broker" that together are geared towards inter-cloud computing which ensures quality service delivery to customers (Aldawood, Fowley, Pahl, Taibi, & Liu, 2016; Pawluk et al., 2012; Yangui et al., 2014). Out of many services, these cloud brokers provide cloud customers with an integrated interface of services offered by various providers. Customers interact with brokers to issue their needs and preferences, and then brokers assess compatible and appropriate service providers to issue their offerings. Then appropriate services are issued to the respective customer. In the end, the broker is issued a commission based on successful deals (Aldawood et al., 2016).

2.7.1 Brokerage Services in Education

In education, advancements in the area of information and communication technology, coupled with the high penetration of the Internet and mobile technologies are ever-transforming traditional education systems. Technology has become an inseparable and indisputable component of teaching, learning and research today (Kukulska-Hulme, 2007). Technology mediated learning such as e-learning, mobile learning; virtual classrooms, as well as remote and distance learning, constitute the present and future trends in education. Technologies offer a multitude of affordances ranging from knowledge and information

sharing to interactions between stakeholders (Kukulska-Hulme, 2007; Mtebe & Kandoro, 2016). As described in chapter two of this research, technologies offer possibilities to incorporate different forms of learning gears, including learning resources such as lecture video, teaching audio, lecture slides/handouts, e-books, downloadable application tools and software. In addition, through the use of communication media learning can happen anywhere and anytime (Ally, 2009). Also, it adds interactivity between learners and teachers in the learning processes by applying media such as e-mail, electronic forums, chatting, video conferencing and other forms of computer, mobiles and Web-based communication (Mtebe & Kandoro, 2016).

The maturity of ICT and Internet systems in connection to the commercialization of education prompted organizations, companies and institutions to venture into electronic-based learning of various forms (Langenbach, 1998). Many actors have become providers of online-based courses and trainings in either web-based or mobile-based courses (Anido et al., 2002). Thus, the online space is overpopulated with courses from various providers from different domains. Like any other business, the existence of online courses attracts the attention of learners across the globe (D'Mello & Achar, 2011). Learners traverse network spaces and nodes to discover relevant and quality learning resources from providers across the globe (Ally, 2009; D'Mello & Achar, 2011). Associated with online learning are the quality control and the accessibility and reliability of the learning experiences. The real scenario is that learners as customers use search engines to retrieve information concerning course offerings associated with the provider of such information (D'Mello & Achar, 2011). From the list of retrieved URL links, learners examine the content of the course before making decisions on whether to enrol or look for another offering. Once they are enrolled and pay for subscription, they can participate in the course by accessing learning resources and activities (Anido et al., 2002).

Research on brokerage services in online education is not new. Especially, scholars have been working on the application of broker systems to mediate interactions between providers and customers as well as between heterogeneous systems (Anido et al., 2002; D'Mello & Achar, 2011). Having a big number of providers of e-learning services to choose from is a big challenge to learners in terms of time needed to retrieve and process information (Malin, Brown, & Trubceac, 2018). Furthermore, like any other online business, quality control of the online courses and content are subjective. Similarly, due to the lack of standards on online-based learning, the heterogeneous e-learning systems from providers are difficult to interoperate and reuse contents seamlessly (D'Mello & Achar, 2011). For decades scholars

are working to address these challenges by deploying models and approaches including those in the following paragraphs.

In particular, Anido et al. (2002) conducted research on educational metadata and brokerage services for e-learning resources. The project aimed at improving the interoperability of heterogeneous systems from various providers. Through standardization of e-learning services, learners are able to access learning resources without being aware of the provider of such resource (Anido et al., 2002). The educational broker works as a mediator between systems as well as between providers and customers helping customers (learners) in the process of resource search and discovery. Through the use of a broker platform, the speed of data discovery by customer and publishing by provider is shortened and the quality of the content is guaranteed (Anido et al., 2002). To ensure sustainability of the service, the owner of the brokerage service relies on the commission offered by respective e-learning providers in accordance to the terms of agreement entered at the start of the service (Anido et al., 2002).

Similarly, D'Mello & Achar, (2011) worked on the "broker based architecture for e-learning" to address the issue of heterogeneous e-learning systems from different providers. Through the use of broker-based web-services, it helped learners to make the best choices and re-use the content. With this approach, the author proposed a specific approach to storing and retrieving web-services for learners. The providers use specific procedures to store their learning objects into a specific database. Likewise, through the use of special procedures and keywords, customers retrieve given information. However, no information is provided on how the customers are informed on the specific ways to make searches from the database. The project is positively evaluated by a series of experiments at Visvesvaraya Technological University in India.

Moreover, the Electronic Education Mall (EEM) idea is another example of brokerage service intervention into electronic learning ecosystems (D'Mello & Achar, 2011). Customers of the online courses leverage from the existence of the broker platform to access course offerings. The broker concept in this work is both a person and technology; while technologies help learner to specify their needs, the person broker uses the retrieved list of possible offerings that relate to the customer and finetune it before sharing the right offerings to the customers. In so doing, brokers (individuals) rely on their experiences and know-how to ensure the quality and relevancy of the learning experience (D'Mello & Achar, 2011). The platform is positively evaluated at the University of Erlangen, Nuremberg.

2.7.2 Brokerage Services and Micro-learning

As it is indicated in the research framework, access and quality control challenges (*items 2.1 &2.2*) triggered the development of brokerage application—Ujuzi App (*item 7*.). Due to the problems associated with micro-learning architecture, a micro-learning course consists of a multitude of independent and focused micro-learning units. Hence, significant effort is required to navigate and process micro-learning units in order to learn (Bruck et al., 2012; Sánchez-Alonso et al., 2006). Also, due to a high number of providers coupled with the democratic nature of the Internet, we argue that learners are subjected to learning materials of various quality levels (high to low). For places such as Africa, where digital and Internet skills are limited, there is no doubt that unskilled learners will be excluded from leveraging the micro-learning potentials. The following scenario describes processes that learners undertake to access micro-learning units from the Internet: a learner starts by typing keywords in a search engine for specific micro-learning contents from the Internet. Next, the list of the URL links corresponding to the keywords displayed in a mobile's or PC's screen. Then, learners have to explore each of the links to decide on the most relevant and suitable content to use. Definitely, for unskilled learners, this process is frustrating and risky.

Hence, as one of the objectives of this study, we present the result concerning the introduction of brokerage services such as Ujuzi App in the micro-learning ecosystem in chapter 6.

2.8 Micro-credentials as a Promising Micro-learning Partner

The use of symbols to communicate status, achievements, accomplishment and commitment to a cause is a historical fact of human society. The symbols of great hunters, animals, trophies and more were found in all archaeological sites across the globe. More importantly, these symbols are in use today for various purposes. For example, bar-codes are used to authenticate products whereas tattoos are used to affirm individuals' commitment to a social group or movement. In the same way, the military and scout symbols represent ranks and accomplishments. The value and meaning of the symbol and how it is used are determined by the responsible communities and issuers of such symbols. Some of the symbols such as those used by the military and scouts are universal with minimal alterations while others are used and understood explicitly by the intended communities. The bottom line for the application of the badge in any society relies on the established common understanding between all stakeholders involved in a complete value chain.

Micro-credentials recognise meta-skills, competencies, achievements and accomplishments achieved by learners, employees, professionals from the issuing agent (Abramovich, 2016; Fong, Janzow, & Peck, 2016). Also, micro-credentials are digital artefacts that can be used to recognize, display, and transmit information about an individual student's skills, abilities, and knowledge (Fishman, Teasley, Cederquist, 2018). When applied in education, micro-credentials are different from micro-credentials usually offered upon completion of the course. According to Davis & Singh (2015), micro-credentials offer learners a mechanism for displaying and sharing a wider variety of achievements than grade-point averages or typical transcripts. It targets one specific outcome of a substantive course or degree program. For example, in a communication skills course, learners upon fulfilling established criteria can earn a "public speaking" micro-credit in the form of a digital badge. Therefore, a badge is the image or symbol associated with micro-credits issued by the specific issuers in recognition of the efforts and accomplishment on successful completion of associated criteria (Davis & Singh, 2015). Unlike other forms of badges, digital badges are comprised of metadata accessible and verifiable by the users of the badge (Dowling-Hetherington, 2017). In addition, the open badges movement headed by the Mozilla foundation make badges inter-operable as well as democratise the 'badging' process (Priest, 2016). The term "digital badge" is relatively new and research concerning its application and effects in various fields are scarce. The majority of scholars believe that digital badges emerged around 2010 in the United States of America from people working with the Mozilla and MacArthur foundations (Fong et al., 2016). The period between 2011 and 2013 marks the time when badge especially open-badge concepts were formulated along the lines of a common infrastructure and framework (Abramovich, 2016; Fong et al., 2016). During this time, technical specifications of the badge infrastructure, the badge design, and how to verify and display were issued (Abramovich, 2016). To date, the improved version of these specifications guarantees interoperability and sharing of the badges across different web platforms as well as social networks. In fact, millions of badges are issued to recipients across the globe. More important, The Mozilla Backpack infrastructure provides a mechanism to store and manage the collection of badges from individuals. By the end of 2016, the backpack contained more than 967,966 badges on behalf of learners around the globe (Fong et al., 2016). Early works suggest both proprietary and open digital badges were used in several ways in different sectors. They were used to represent achievements and claims of hard and soft skills, participation and official certification as well as authorisation and community involvement (Abramovich, 2016). Traces of earlier implementation can be found in professional

development especially teachers and nurses development (DeMonte, 2017). Due to the open infrastructure, teachers and nurses were able to utilise the online materials from the Internet to improve their skills and later claim such achievement from various issuers of the badge (DeMonte, 2017). Unlike the traditional professional development projects that rely heavily on the training event and activities, this mode is fast and cost-effective. Learners decide what, when, where and how to learn, and due to the openness, learners pursue different routes to achieve the same skills. Therefore, it motivates personalised, connected, as well as lifelong learning (Gibson et al., 2015). The application of digital badges and micro-credentials in education especially in higher education is a work in progress (Abramovich, 2016; Fong et al., 2016; Gibson et al., 2015). Literature suggests that micro-credentials work better in informal education than formal settings due to its flexibility (Hickey et al., 2015). Formal education requires a well envisioned structured approach comprised of a series of topics as well as activities that are assessed as a whole and represented in the transcripts. Also, formal education is organised around the teacher-centred philosophy whereby learners are not in control of what they want to learn. Particularly, there are two common approaches used to deploy digital badges in education: complimenting the existing credentialing systems: this involves adding skill-based modules that require learners to put some optional efforts in order to earn badges, and the total integration of badges as part of formal credentials that learners have to earn on top of traditional credentials (Abramovich, 2016; Gibson et al., 2015). Further, academic institutions open up their boundaries to allow people who are not formal students to claim university credit in the form of digital badges. However, despite the high motivation by various research institutions and foundations across the globe, micro-credentials uptake in academic institutions is low across the globe (Fong et al., 2016; Gibson et al., 2015; Hickey et al., 2015). This is attributed to the lack of awareness and participation of employers as well as admission officers of the academic institutions (Hickey, Iii, & Quick, 2015). Thus, learners and badge recipients are not assured of their acceptance in the labour market as well as in their further education and training. Also, while there are several initiatives and movements across another part of the world to inspire the adoption of the new credentialing system, such efforts are missing in Africa. The badge ecosystem requires an enabling infrastructure that ensures the quality of services as well as cooperation from stakeholders such as employers, educators, issuers, endorsers as well as policymakers in all sectors (Gibson et al., 2015). Apart from the infrastructure, the policies and skills of the stakeholders towards design, administration as well as the execution of the project is vital.

The preceding discussion on digital badges has outlined its potentials. Specifically, we argue for the integration of digital badges in the micro-learning ecosystem to improve acceptance and recognition of the skills. If recognized, integrated and used by the employers, it will stimulate learners to acquire skills from across the globe and immediately be recognized as they are able to showcase and prove their achievements practically.

In this work, we explore readiness issues related to micro-credentials deployment in HEIs in Tanzania (*refer to item 1*). It is imperative that the findings presented in chapter 4 will help policy-makers, educators as well as research communities and institutions, especially in Africa to expand their understanding and reach.

2.9 Chapter Conclusion

The above discussion on "*Supporting Micro-learning Access through the Ujuzi Mobile App: A Brokerage Deployment Model and Pilot Study for Tanzanian Higher Education Institutions."* proposes a model that is flexible and holistic enough to address issues of interest in the ever-changing learners' context. Also, it explores the role of brokerage services in micro-learning ecosystem. It is now clear that micro-learning implementation differs from one context to another; models designed for certain contexts only are risky. We insist on the involvement of relevant stakeholders in the process of designing a relevant solution that fits the situation.

Because micro-learning is still in its infancy, there are several issues that need to be addressed by scholars including lack of design compatibility due to the device OS, lack of unified or reliable approach to implementing technologies in the institutions, the fast-changing mobile landscape, sustaining the deployed projects and integrating pedagogy into the designs. On top of that, the lack of digital awareness and pedagogical skills among educators and policymakers impacts the ability to benefit from the proliferating mobile devices.

The research framework outlined in figure-1 highlights key concepts that this study has adopted in order to achieve the intended objectives. Also, we have outlined how to combine the CTT, Connectivism and the DSR theories in micro-learning deployment project. Students, teachers, ICT experts participate in the process of identifying, designing and evaluating the artefacts as required by the DSR. Also, teachers and students are involved in the process of applying micro-learning applications in their learning activities to evaluate how well it promotes Connectivism -based learning. The process helps to explain the contribution and

effect of technology in the learning process. Also, it helps to identify challenges and opportunities for future works to address.

It suffices to say that mobiles are actively changing our ways of life. They are instrumental in facilitating communication, interaction as well as connection to the global network and resources. Through the literature, we can infer that well-deployed systems can contribute to eradicating digital gaps as well as empowering marginalized societies. Institutions in the regions with fewer resources can benefit a lot from mobiles penetration as illustrated in our case-studies of Tanzania higher education institutions in the coming chapters.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The research methodology is a pivotal component of social research. It provides a logical description of key steps, methods and processes necessary for achieving the intended research objectives. Therefore, this chapter presents discussions concerning research philosophy, design, methods as well as ethical issues.

On top of that, we provide a critical account of limitations that might have affected the scope and strength of this work. In the end, after reading this chapter, one will be able to understand how the researcher was able to conceptualize and translate the pertinent social problem at hand and make important and justifiable choices amongst possible options concerning issues including study population, approaches and methodologies. Also, we provide a detailed account of processes undertaken to ensure the integrity of the work and the privacy of our respondents.

Because micro-learning is a socio-techno-pedagogical concept, the primary focus of this work was on democratizing the processes that lead to the deployment of artefacts to the intended audience. Therefore, in this chapter, we provide critical discourse on how stakeholders became part of the problem formulation, artefact design, as well as evaluation and publications. This includes all activities related to data collection, analysis as well as participation in the experimentation of artefacts such as an app at various stages. To ensure consistency of the work, in making choices, we rely solely on the theoretical framework discussed in chapter 2.

For smooth digest, this work is organized as follows. The chapter introduction is followed by discussions concerning research philosophy in section 3.2. Thereafter, the methodology of the study is detailed in section 3.3. In this section, we present a detailed account of all processes required by the Design Science Research Methodology, including some aspects of co-creation and co-designing of artefacts. Section 3.4 will present detailed discourses related to research ethics before introducing factors that limited the conduct of this work in section 3.5. The chapter ends with a concluding summary that is presented in section 3.6 hereunder.

3.2 Research Philosophy

Research philosophy implies assumptions and lenses that shape how research enquiries are carried out (Holden & Lynch, 2004). They consist of fundamental beliefs that researchers need to abide with before attempting to conduct research. They are the beliefs on the availability of "truth" or "reality", as well as the ways to search for reality, thus dictating choices concerning methods to use (Holden & Lynch, 2004). More specifically it is argued that the choice of research methodology should be consequential to the researcher's philosophical position and not the vice versa (Sutrisna, 2009). Central to the discussion at either ontological or epistemological levels is the issue of objectivity versus subjectivity of the research methods. Significantly, decisions need to be made on the involvement of humans and societies against the use of scientific means. There are three main levels of assumption characterizing a researcher's philosophical camp: ontology, epistemology and methodology. The ontological position of the researcher is crucial as it determines the epistemological as well as methodological choices (Sutrisna, 2009). In the next proceeding paragraphs, we describe the philosophical lens that our study is grounded in.

Research Ontology is a philosophical position that addresses belief and assumptions about "what exists or the nature of reality" (Neuman, 2011). It points out what a researcher believes concerning the nature of what is studied; whether "truth" or "reality" about it can be realized through scientific means or rather human actors in society create the meanings of their social phenomena (Holden & Lynch, 2004). In fact, the philosophical camps on truth and reality are divided between realists, also known as objectivist, and the nominalists, also known as constructionist (Neuman, 2011). Other perspectives occupy middle ground with approximate moderate stances, which support or deny some aspects from the two main camps.

The realistic position to the nature of reality stems from natural sciences, that reality exists out "there" away from human intervention (Neuman, 2011). They assume an "absolute truth" and laws in such a way that scientific methods are the only means to uncover "truth" or realities (Holden & Lynch, 2004; Neuman, 2011). Constructionists take the opposite stance that reality and what exists is continually constructed by human actors. They believe that people attach meaning to everything around them as the reason and experience lived (Neuman, 2011). Therefore, in order to discover reality, the constructionist camp involves and collaborates with individuals in their particular context. Furthermore, the realists believe that the reason for conducting research is to find the truth or prove the established theory whereas for nominalists the focus is to understand the complex social phenomena.

Micro-learning deployment is a social phenomenon that affects education settings, educators and students. Their deployment requires investing in technological infrastructure, human capital, social transformation, as well as policy adjustments. Also, universities differ in their culture, philosophy and capacity that makes it impossible to generalize deployment choices and approaches. Therefore, understanding the context in which deployment is expected as well as attitudes and preferences of the stakeholders is crucial. Our ontological position lies midway between the two opposing camps in such a way that we believe and assume that reality can be realized by a combination of scientific methods while we should involve people to understand the meaning of their social phenomena. Scientific methods can help to predict and generalize meanings, whereas people from a particular social setting are needed to construct meanings and explain particular situations.

The second important philosophical decision that researchers make is on the research epistemology, "the study about the nature of knowledge" (Holden & Lynch, 2004; Sutrisna, 2009). It is concerned with how knowledge can be acquired at the philosophical level: what approach should be used to process and gain knowledge (Neuman, 2011). The epistemological choices are linked to the ontological choice made earlier, for example, if the researcher assumes that reality is constructed by the actors then their epistemological choices need to reflect the same, their epistemological position requires they involve individuals in constructing the meaning in the form of answering research questions (Sutrisna, 2009). There are three common epistemological camps that social researchers choose between positivist, interpretative, and critical-social. These epistemological bases differ in many things, including the assumptions they make concerning the value of common sense and science, the ways they validate knowledge as well as issues related to theorizing knowledge. More importantly, they also differ in the purpose of conducting social research as described next.

According to the positivist camp, knowledge can be acquired through the application of scientific methods and theories (Neuman, 2011). These are aligned toward realist's ontological beliefs and assumptions. They assume that social reality can be understood through the lenses of known models and theories in such a way that individuals and social interpretations of the phenomena are void (Neuman, 2011). In order to achieve "reality", researchers conduct literature reviews in order to identify gaps and approved theories from which they can deduce knowledge (Holden & Lynch, 2004; Neuman, 2011; Sutrisna, 2009). Yet, the interpretive camp believes that reality is inbuilt into individuals living in a certain context such that there is a need to involve them in the processes of constructing knowledge. This position is associated with the claim that not everything or every situation can be

explained through scientific methods. Interpretive researchers are not required to formulate hypothesis before they conduct studies because to them, reality is not bounded by laws of nature. Instead of using the established theories in their search for reality, they spend more time with individuals to understand phenomena and later, inductively, they formulate theories based on their interpretation of participants' perspective of the social phenomena.

Another distinguishing factor is the role of social theories. Positivists assume that social theories are universal and they affect societies in the same way; they can be generalized to the rest of the societies. Therefore, in order for research to be objective, they should involve a large sample so as to minimize errors in the mathematical models (Marshall, 1996; Neuman, 2011). On the contrary, interpretivists are not concerned with the generalization of the theories; they believe situations are contextual, and they can be addressed differently across the globe. Therefore, all research abiding by the interpretive perspective is more focused on the understanding of the situation in the deepest possible way. Thus, the least knowledgeable and affected members of the social group are involved (Neuman, 2011). From these conflicting arguments, data collection and analysis are carried out with different purposes based on one's perspective, for the positivist data are only collected in order to prove or test a hypothesis aligned to the established theories. They apply quantitative data collection methods such as observation, experiments and survey (Neuman, 2011; Sutrisna, 2009). On the contrary, interpretive researches apply qualitative methods that facilitate users' involvement, including in-depth-interviews, document reviews, and open-ended questions.

Another epistemological position is that of critical social scientists, who agree with some views and arguments from both positivist and interpretive camps (Neuman, 2011). On top of those, they add new insight on how knowledge about reality is realized. Critical theorists argue that both scientific and non-scientific methods can be used to explore the nature of reality, depending on the focus of the study. They share the interpretive criticism on positivists that human beings have a cognitive and logical sense that is essential in understanding social phenomena in a respective context (Neuman, 2011). In other words, they accuse positivists of being inhuman and anti-democratic for not appreciating the human capacity in understanding and constructing meaning. They argue that the use of scientific methods alone to observe and understand social reality is not viable. At the same time, critical researchers distance themselves from interpretive methods as they view them as being too subjective and relative, they rely too much on the opinion and idea from their subjects rather than focusing on the actual situation to solve (Neuman, 2011). After all, the primary

purpose of critical research is to transform at macro-level: to tackle social problems, including conflict resolution as well as challenging the status quo.

There are several versions of the critical social ideology in which the theories such as feminist, radical psychotherapy and critical theory are applied (Neuman, 2011). They address issues such as gender inequality, famine, labour-related conflicts, ethnicity and other more. Currently, issues such as the digital divide and refugees' crisis attract much of critical social research. In order to address social problems, critical social researchers work together with the respective societies to study their social problems and take actions that solve the identified problems. Unlike positivists and interpretivists, the work of critical social researchers does not end with explanations or prediction, but actions. Through action research, members of the society work together with the critical researcher to identify their social problem and the cause of such a problem, and then together they derive a solution for the problem. Through the application of scientific methods as well as participant's reflective experience, researchers understand phenomena and formulate theories related to the situation.

As described before, the successful deployment of micro-learning services required a holistic approach that involves all stakeholders. The mobile initiatives need to be aligned with overall university policies and strategies. As critical theorists argue, the value of technology is shaped by the needs of the users. Our role in this study was to understand the situation, develop artefacts and then apply the artefacts to institute change within universities. Such activities require predicting user behaviour, understanding the reality as well as transforming the situation. Therefore, critical social science position became the relevant epistemological approach of the study. It helped to understand the phenomena as well as deploying technologies that proved to be useful in imparting knowledge to students "anywhere" and "anytime". Specifically, students, educational technologists and educators evaluated the Ujuzi app and a Micro-learning Deployment Model as useful in addressing skills need, access to quality micro-learning content as well as implementing micro-learning service in HEIs in Tanzania and beyond.

3.3 Design Science Research Methodology (DSRM)

The DSRM is the guiding methodology in this study. As previously described, this study explores phenomena concerning micro-learning access and deployment and develops a model that is suitable for HEIs in Tanzania. It is an explorative study that uses the insiders' perspectives to develop artefacts in the form of the mobile app and a model that will be used to describe and address the same situation in the future. Our ultimate objective was to

combine the needs of the users and institutions with available theories to deploy micro-learning services to academic audiences. Hence, both the DSR approach and DSRM fit well with the chosen research philosophy at all levels. Combined with the Critical Theory of Technology and the Connectivism, they offer the researcher the freedom to involve both human actors as well as scientific methods in the process of artefacts development.

The DSRM is commonly used in conducting information systems (IS) studies aligned to solving business problems through artefacts creation (Hevner, 2007, p. 200). Design science researchers work with stakeholders to explore their situations before artefacts are created. The present study explored situations related to micro-learning access and deployment and came out with artefacts in the form of a deployment model and the Ujuzi mobile app that addresses the identified problems. As described by Hevner, March, Park, & Ram, (2004), a typical design science research is comprised of three important cycles: relevance, design and rigor cycles. Design science researchers explore the environment such as the organization to identify the relevant problem(s) that need(s) to be addressed during the relevancy cycle. Through the use of domain knowledge, they verify to see if the identified problem(s) is unique and cannot be solved by the available artefacts and has potentials to improve the situation as well as contribution to the knowledge. Also, in order for the study to be credible, it needs to add new knowledge to the domain knowledge. Hence, design researchers have to evaluate their artefacts by using the established methods and theories during the rigor cycle (Hevner, 2007). On the other hand, the actual development and evaluation of artefact is done during the design cycle in which researchers use the specifications co-obtained from the environment to build the artefact. Then, the developed artefact is evaluated by the users to see if it fits their needs. Also, it is evaluated against the established theories to ensure its rigour. Principally, the build-evaluate process is iterative; it continues until when the artefact is suitable for the purpose. Finally, when the evaluated artefact is approved, researchers communicate the output to the intended audiences. During the relevancy cycle, we conducted situation analysis in the aforementioned four universities to understand the phenomena, then during the design cycle, we designed and developed two artefacts in the form of a model, and an instantiation as detailed in chapters 6&7. In fact, the artefacts are evaluated by using established methods as well as by applying established theories (rigor cycle) (Gregor & Hevner, 2013). Figure 3-1 below provides a snapshot of the three design science cycles.

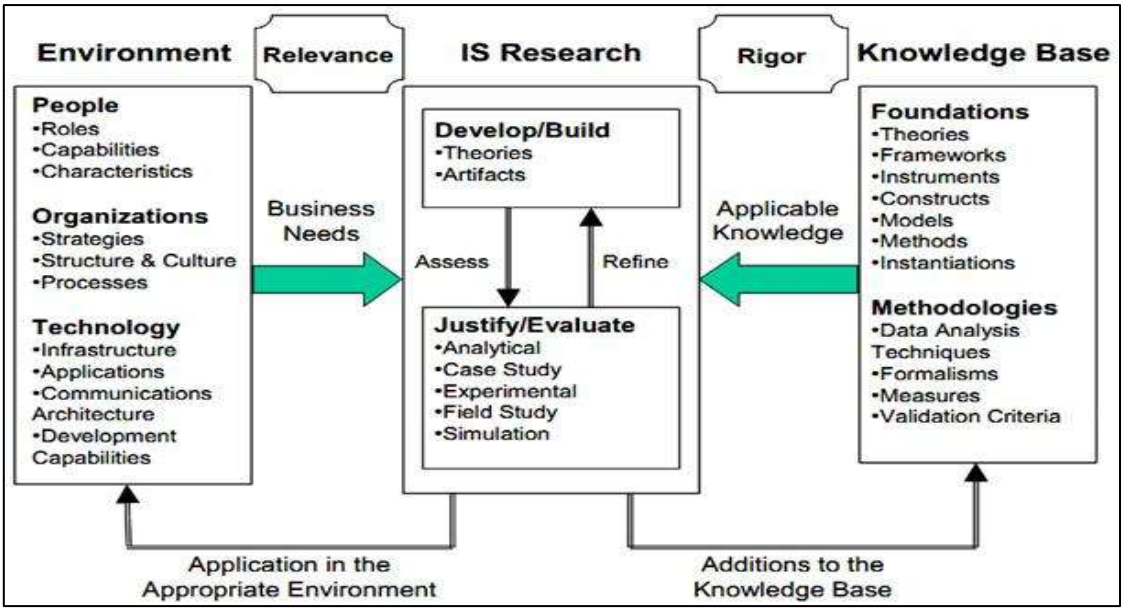

Figure 3-1: Design science framework adopted from **(Hevner et al., 2004)**

Although DSR focuses on IS based research, DSRM is not confined to methods that exist in natural science alone; it is acceptable for design science researchers to apply theories brought from other domains including social sciences (Offermann, Levina, Schönherr, & Bub, 2009). In order to ensure relevancy and rigour of the study, the need to consult literature and apply a rigorous method is emphasized by various authors (Hevner, 2007; Peffers et al., 2006). Also, both quantitative and qualitative methods can be used when aiming to understand the needs of the people (Offermann et al. 2009). Similarly, both methods can be used to collect experts' advice as well as to validate the quality of the artefacts. They include methods such as interviews, case studies, experiments, survey, action research, grounded theory and ethnography (Hevner, 2007; Offermann et al., 2009). Also, it is acceptable to use more than one method whenever applicable. In this study, we applied multiple methods during data collection, analysis and evaluation. They include qualitative methods as they are efficient in explaining complex situations in a required depth. Also, quantitative methods were used because they are good at examining attitudes, perspectives as well as behavioural aspects of the participants concerning the phenomena (Coyne, 1997; Marshall, 1996; Neuman, 2011).

The DSRM, also known as "design science process model" comprises six processes: problem identification and motivation, the objective of the solution, design and develop, demonstrate, evaluate and communicate as shown in figure 3-2. These processes are essential for conducting, evaluating and communicating every design science work. In the coming section, we describe how these processes are applied in this work:-

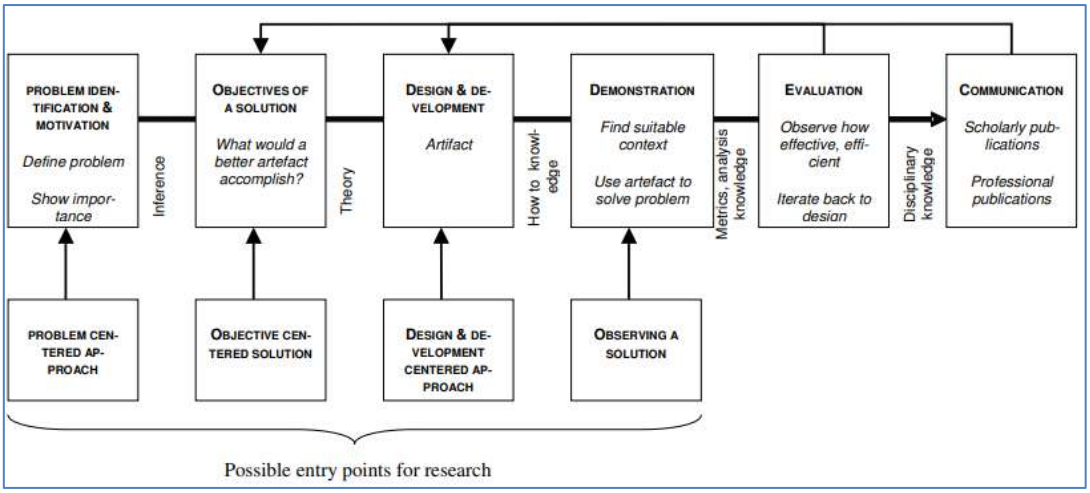

Figure 3-2: Design science methodology process model ***(Peffers et al., 2006)***

3.3.1 Identify Problem and Motive

The first step during artefact development is to identify a social problem(s). During this stage, researchers work with experts and individuals within the respective settings such as organization or society in order to identify a relevant social problem worth devoting resources in solving them. Generally, the environment is comprised of organization, technology and people. Individuals and organizations have different perceptions regarding any situations which make it harder to agree. Thus, in this study, the author first conducted a literature review on micro-learning studies to identify problems. There are four common problems in the area of mobile-based learning implementation: (1) limitations attributed to the capacity of mobile devices; (2) the lack of interoperability of the mobile application; (3) access issues as related micro-learning units (4) the lack of deployment model.

In order to justify problem relevancy, the researcher worked with stakeholders to identify their perspectives regarding micro-learning. The first part of the study (objectives 1&2) involved situation analysis of the environment to identify issues. It provided a detailed specification of the problem. The stakeholders include members of academic communities, namely the Mzumbe University, the Open University of Tanzania, the University of Dodoma and the University of Dar es Salaam as detailed in the coming sections.

3.3.1.1 Study Population (field site)

One of the key aspects of any field research is to describe the location or setting to which studies are conducted. These locations or settings belong to participants whose perspectives of the phenomena shape those studies. Researchers are obliged to select a field site that not only corresponds to the study questions but also is suitable, accessible, affordable, and that can offer rich data (Neuman (2011). Significantly, the selection of the site is purposeful;

researchers need to align their needs with the situations on the ground, including the availability of support, budget and language barriers (Miller & Costa, 2016). Moreover, there is a need to examine whether there is a possibility of being accepted into the population.

The Tanzania higher education scene is composed of thirty-three universities, sixteen university colleges, and twenty-one university campuses (TCU, 2019a). Our focus is to explore situations in public universities that are prominent in learning with technologies. Our literature search for technology-mediated, learning, blended learning, e-learning, and mobile learning indicates that Mzumbe University (MU), the Open University of Tanzania (OUT), the University of Dar Es Salaam (UDSM) and the University of Dodoma (UDOM) are the prominent institutions. Several studies on the use of learning management systems (LMS) have been conducted in these sites. Also, the existence of the community of people who have experience in learning with technologies made these sites ideal for this study. It helped the researcher to explore these experiences as well as expectations. Besides, very little is known about other institutions with regards to initiatives directed towards learning with technologies. Also, the chosen universities are accessible, and their situations represent other public universities in Tanzania.

Moreover, these sites have varied experiences when it comes to deploying technology-mediated learning. We can distinguish four categories.

- OUT represents those universities that have the mandate to run full-scale e-learning courses to her distance students;
- UDSM offers both blended and full-scale e-learning courses and has experience for over ten years;
- MU represents the country's emerging universities in the area of learning with technologies. The experiences gained from these universities can be extrapolated to other public universities who are at different stages of implementation.
- UDOM represent is the only university in Tanzania that offers courses on technology-mediated learning. Also, like UDSM, UDOM has a dedicated centre of virtual education.

Specifically, the University of Dar es Salaam is the oldest university in Tanzania. It is situated thirteen kilometres from the city centre, on the western side of the city of Dar es Salaam. Its history started way long on July 1961 as a university college, an affiliated college of the University of London. Then, in 1963 it became a constituent college of the University of East Africa together with Makerere University College in Uganda and Nairobi University

College in Kenya. It was established as a full university in 1970 through the parliament act no. 12 of 1970. Currently, the university has three schools, four institutes, two constituent colleges, and six campus colleges that offer certificates, diploma, bachelor, master and postgraduate degree programs. Courses offered by the UDSM covers all domains including natural and applied sciences, engineering and technology, arts and education, as well as business and social sciences. It is regarded as one of the largest universities in Tanzania with an enrolment range of between 15,000 to 19,999 students (TCU, 2019b).

The UDMS possesses the extra experience of being the only university in Tanzania that offers both distance and non-distance courses. Being a public university, it enrols students from different socio-economic backgrounds that make it interesting to study their perspectives as related to mobile-based learning. Unlike other universities such as MU, UDSM has a dedicated centre for virtual learning (CVL) that facilitates learning with technologies. Furthermore, being at the heart of Dar Es Salaam, students are known to be engaged in various activities that limit their presence at the university. Thus, the dynamics of the environment, the organization structure, student, and staff experiences provides this work with needed data on micro-learning technologies and deployment approaches.

Next, the OUT is a fully-fledged, autonomous and accredited public university. It was established by the parliament act no.17 of 1992 and became fully operational in 1994. It offers certificate, diploma, degree and postgraduate courses through open and distance learning system in various fields including law, business management, science and technology, arts and social sciences. Unlike other universities, by the year 2006 data, OUT had 5,176 distances based students. Most of the courses are conducted through various means of communication including limited face-to-face, broadcasting, telecasting, correspondence, and seminars, e-learning as well as a blended model, which is a combination of two or more means of delivery. Apart from offering their prepared course materials, it has extended its reach by integrating courseware from world reputable institutions, including the Massachusetts Institute of Technology (MIT).

Currently, the OUT is temporarily located in Kinondoni Municipality, Dar es Salaam, while the construction of the permanent offices at Kibaha District is ongoing. It operates in a network of about thirty regional centres and ten coordinating centres, of which one is in Unguja and one in Pemba; two are in Kenya (Egerton and Njoro), one is in Rwanda (Kibungo), one in Namibia and one in Uganda. Also, OUT owns sixty-nine study centres spread throughout Tanzania. These attributes made this site suitable for conducting our study.

Particularly, it was important to explore phenomena experienced by students and educators who work in distant environments.

Third, Mzumbe University (MU) became a fully-fledged public university under the parliament act no.21 of 2001. It was chartered in 2007 under section 25 of the universities act no.7 of 2005, which repealed the Mzumbe University Act no.9 of 2001. Its origin can be traced back in the year 1953 when the British colonial administration established the Local Government School in the country. In 1972, the then Local Government School was merged with the Institute of Public Administration of the University of Dar es Salaam to form the Institute of Development Management (IDM-Mzumbe), with a mandate to train professional managers in public and private sectors. Currently, the university has three campuses in three regions: Dar es Salaam, Mbeya and Morogoro. On top of that, the university owns training centres in Mwanza and Morogoro town.

Further, MU is located about twenty-five kilometres from Morogoro town in the Mvomero district. Boosted by over fifty years of experience, the university offers certificate, diploma, bachelor and postgraduate studies in various domains including law, applied and social sciences, education and business management. Unlike UDSM and UDOM, there is no organ dedicated to facilitating learning with technologies. The Directorate of Information and Communication Technology (DICT), with its primary role to manage the university's ICT infrastructure, coordinates activities related to learning with technology. From 2009, MU started to deploy learning management into its courses. Unlike other field-sites, application of learning management system (LMS) at MU is intended to complement the traditional face-to-face system. At the moment, there is no distance-based course offered by the university.

As described earlier, for being a public university, MU shares a number of problems and challenges like other universities in such category including crowded classrooms, limited infrastructure, and limited skills amongst employees. Also, there are students from different social, economic backgrounds as well as ethnicity. Through collaborations with partner institutions such as Vlir-UOS, there are efforts to enhance the learning experience through the use of emerging technologies. Mzumbe is chosen in this study to represent young public universities that have just started to implement learning management systems (LMS) into teaching and learning.

In addition, UDOM was established in March 2007 and became operational in the same year. It is located at Chimwaga area, about eight kilometres from the city of Dodoma, the capital of Tanzania. It is regarded as the largest university in the eastern and central Africa region with the capacity to enrol up to 50,000 students at once. Administratively, the university has six

colleges that are located within 6,000 hectares of land. One of the interesting features that made this site to be chosen is the College of Informatics and Virtual Education (CIVE) which is entrusted with overseeing the delivery of academic programmes in a virtual environment within and beyond the university campus. Among other things, CIVE is responsible for managing virtual infrastructure as well as content production and dissemination. Although CIVE is similar to the UDSM's CVL, its mandate includes offering programs on technology-based learning, which is not the case at UDSM.

Also, UDOM is the youngest university that has no root in other universities. A huge investment was done by the government of Tanzania to connect the university with the rest of the country through a national fibre backbone in order to stimulate learning experiences. Several digital applications, including learning resource management systems, are in place. Being the youngest university that is not linked to any other, it has a chance to create its own culture that cannot be found in other universities. Also, the university is located not too far from Morogoro; it is accessible by the researcher. These characteristics made UDOM an important place to study micro-learning deployment.

3.3.1.2 Sampling Technique

One of the crucial requirements of social research is to describe the sampling technique that is used while carrying out research activities. More important is to describe how the sample was drawn from the population (Neuman, 2011). Sampling is an important aspect of the research because, in practice, it is not feasible and ethically appropriate to involve the entire population in a study (Marshall, 1996). Also, it is a pre-requisite for all research bodies, including ethical committees and funding agents, to declare the nature of the participants as well as how they are drawn from the population so as to certify its relevancy and representativeness (Coyne, 1997).

There are debates among researchers from qualitative and quantitative camps concerning the appropriate sample size as well as sampling methods. These debates are centred around the aim of the sample and sampling methods, while quantitative research is focused on testing hypotheses through the use of a representative sample so that they can generalize findings, qualitative researches are more on the appropriateness of the sample (Coyne, 1997; Marshall, 1996; Neuman, 2011). On the one hand, quantitative researchers are forced to ensure that their samples are large enough to represent the rest of the population because it is accepted that the larger the sample, the fewer the chances of error in the produced result (Marshall, 1996). On the other hand, qualitative researchers are not concerned with the numbers

(quantity); they are focused on understanding the complex situation at its deepest level possible (Coyne, 1997; Neuman, 2011). Therefore, what describes the sample is the ability to contribute to leverage from their experiences, knowledge and involvements in the situation or social problem. Also, qualitative researchers are not forced to declare their sample prior to the conducting of the study because it is the progress of the research that guides what data to collect, whom to involve and where to go and collect new data to either explain or verify the emerging theories (Coyne, 1997; Marshall, 1996; Neuman, 2011). During the conduct of qualitative studies, researchers continuously compare the emerging theories with literature and new concepts and adjust it accordingly until they reach a saturation point. The saturation point is reached when no new categories, themes or explanations are obtained from the proceeding interrogations with the data sources (Corbin & Strauss, 1990).

Generally, there are several sampling techniques used in social research. They can be grouped into two broad categories: probability and non-probability based sampling (Coyne, 1997; Neuman, 2011).

- Probability sampling approaches, such as random (systematic) sampling, involves describing the nature and characteristics of the population to study. Once they are described, all members of the population possess an equal chance of being drawn in the study despite their knowledge or involvement in the situation or social problem.
- Non-probability sampling methods such as purposeful or theoretical sampling involves drawing participants based on merits embedded into answering research questions (Coyne, 1997; Marshall, 1996; Neuman, 2011). In qualitative research, non-probability sampling methods are required to critically choose participants based on their knowledge, experience, and involvement in the situation or social problem under investigation. Therefore, researchers familiarize themselves about the participants whom they wish to include in their studies and what kind of data they will likely generate (Coyne, 1997). It is argued that non-probability sampling such as theoretical sampling is the flexibility to expand their studies to include all important phenomena (Boellstorff, 2012).

Apart from the debate on the validity of the sample or sampling methods, there exist challenges and confusion on describing sampling methods within qualitative researches. Precisely, these confusions are because of unclear and overlapping boundaries between theoretical sampling, selective sampling and purposeful sampling (Coyne, 1997). In the coming section, we describe common sampling techniques in qualitative research.

One of the common sampling techniques is convenience sampling, which involves selecting the most accessible participants in the population regardless of their ability (Neuman, 2011). In most cases, this approach is not regarded well within the academic community as researches using this kind of sampling methods are likely to produce poor quality results that lack academic credibility (Offermann et al., 2009). Next, the purposeful sampling method is guided by research purpose; subjects are selected based on merits and possible contribution to answering research questions (Draucker, Martsolf, Ross, & Rusk, 2007; Marshall, 1996). In order to apply this method, researchers are supposed to know the area, participants and research variables. They are supposed to make decisions that will help the study in general critically. Then, selective sampling is like purposeful sampling, the researcher decides on sample based on knowledge of the studied situation, study population as well as variables to be studied. Also, during the research processes researcher might decide to call other informants based on the emerging theory in order to test, confirm or explain the theory.

Moreover, theoretical sampling, as described by Graser & Straus "is the process of data collection and analysis based on the progress of the emerging theory" (Neuman, 2011). It is much linked to grounded theory as Draucker et al. (2007) put it as "a hallmark of grounded theory". It is almost impossible to describe theoretical sampling without mentioning grounded theory (Coyne, 1996).

Research conducted by Draucker et al. (2007) found that there is confusion about how different researchers use theoretical sampling. In most cases, the confusion lies between theoretical sampling and purposeful sampling. The common argument is that all decisions made to recruit participants are based on understanding their role in the study. Therefore it is purposeful. This includes the initial sample which is decided on purposefully. The consensus is that theoretical sampling is just a "variant of purposeful sampling" approaches (Coyne, 1996). Also, it has been argued that it is impractical to start research without describing the sample, it is a requirement to describe the study sample to the research bodies including the ethics committee and funding bodies before the study is approved (Coyne, 1997). Therefore, qualitative studies apply both selective sampling and theoretical sampling (Coyne, 1997). Selective sampling is used to pre-define variables, location and sample before starting the study. Hence, a theory generated from this group can be expanded by the theoretically sampled participants.

This study employed random, selective and theoretical sampling methods. Selective sampling was used to pre-describe the initial sample that was used to start qualitative enquiries. Then theoretical sampling enabled the researcher to make decisions concerning the next data to be

collected and participants and their location to be involved based on the emerging theory created from the original sample (Coyne, 1997). Because the Grounded Theory was used to analyze data, the use of theoretical sampling provided needed flexibility to the study (Creswell, 2007). For example, it helped the researcher to include participants from the college of education at UDOM as soon after encountering a deadlock at CIVE.

The initial sample was decided based on the researcher's experience and understanding of the study area from the sampling units. Because the researcher is a member of the university community he has experience in systems deployment, policy-making and dealing with academic staff as well as students. Moreover, the random sampling approach was used during quantitative enquiries to students, ICT experts and academic staff at all universities. This is due to its associated strength as described before.

Therefore, the sample for the study is composed of students, academic staff, ICT experts, as well as members of the management team from the four universities as detailed in the coming sections.

3.3.1.3 Sample Size

Based on the discussion above, the qualitative enquiry, especially those applying theoretical sampling approach, is not controlled by the sample size (Coyne, 1997). Unlike in quantitative research, qualitative studies are focused on understanding the meaning and not a generalization of the findings. Therefore, frequency is not important if the numbers do not constitute new information (Mason, 2010). The consensus that we concur with is that the actual sample size is determined after reaching the saturation point when there is no more themes or categories to be discovered (Coyne, 1997; Draucker et al., 2007). A study conducted by Mason (2010) revealed that most of the PhD studies that involved qualitative methods had a higher number of participants compared to average suggested sample size by the prominent authors, fifteen to fifty respective to the method used.

This work applied both qualitative and quantitative methods at different stages. Hence, in total, the sample size was 407 of which 100 participated in the qualitative interviews.

3.3.1.4 Research Method

In order to explore social phenomena, researchers apply different methods to collect and analyze data. Both qualitative and quantitative approaches were used in this study. For qualitative research, the commonly used methods are categorized into "observations, interviews, documents, and audiovisual materials" (Jacob & Furgerson, 2012). For

quantitative research, the commonly used method is a survey whereby the researcher prepares questionnaires to the respondent (Jacob & Furgerson, 2012). The description of the methods used in this work is provided below:

3.3.1.4.1 Participant Interview

An interview is a data collection method that is widely used to collecting opinions, experiences and perception of social phenomena from the interviewees. They are like the ordinary conversation of which a researcher tries to understand social situations by questioning the participants. The contrast is that interviews are structured and systematic in such a way that the questions are directed towards specific research questions. Also, the choice of the interviewee is based on how much they are able to contribute towards research objectives (Neuman, 2011). As it has been explained by Jacob & Furgerson (2012) "when we interview, we ask people to share their story", interviewers use their skills to inspire participants to give credible information. There are three main types of interviews: structured, semi-structured, and unstructured interviews (Neuman, 2011). Structured interviews, also known as formal interviews, contain a standardized set of questions that interviewers ask. Often these questions are closed-ended. Also, the flow of questions follows a pre-defined order and questions are asked strictly as they appear in the interview guide. On the other hand, unstructured interviews use open-ended questions and flexible interview guides that can be extended based on how respondents answers questions (Neuman, 2011).

In this study, during the problem identification stage, we used semi-structured interviews to explore the insight from participants so that we can understand the situation better. The semi-structured interview guide is comprised of both open-ended questions that require an in-depth explanation from participants and closed questions that are intended to limit participants into sets of answers. A total of one-hundred interviews were conducted as presented in Table 3-1

	#Management	#Lecturer	#ICT expert	#Student	Total
MU	*2*	*5*	*2*	*10*	19
OUT	*2*	*8*	*2*	*10*	22
UDOM	*2*	*7*	*2*	*18*	29
UDSM	*2*	*10*	*3*	*15*	30
Total	8	30	9	53	**100**

Table 3-1: Sample composition of the respondents

3.3.1.4.2 Documentary Review

It is another data collection method that researchers use to understand phenomena based on organizational artefacts such as reports, policies or secular. It could be used to verify insights presented by the users to see if they conform together, or it could be used to further explain the status of policy and strategic alignment to the phenomena. In our work, we reviewed institutional policies and strategic documents from the four universities to understand to what extent they are aligned towards technology-mediated learning as well as fostering learning through didactic approaches. In addition, national ICT policy, as well as ICT or e-learning policies from KIUT, SUA and MUHAS, were explored.

3.3.1.4.3 Surveys

Also, we used a survey to collect stakeholders' opinions concerning micro-learning deployment in higher education institutions. In this survey, questions depicting stakeholders' attitude, perception, demography, and challenges towards micro-learning were asked. In total, 307 participants participated in the survey.

3.3.2 Define the Objective of the Intervention

It is a requirement for any design science research to produce two types of outputs: artefact and scientific knowledge. The artefacts produced in this study are two: the Ujuzi mobile app and a micro-learning deployment model. The overall objective of the solutions (interventions) in this work is to simplify the process of micro-learning access and deployment in HEIs, especially in Tanzania. The Ujuzi app is a brokerage service developed to connect learners and issuers of micro-learning services. Particularly, the app addresses the problem of navigation associated with the difficulty to access micro-learning units as detailed in chapter 6. Also, the micro-learning deployment model addresses challenges associated with the deployment of micro-learning services by bringing together important components necessary for micro-learning to happen.

3.3.3 Design and Development

The design and development phase is responsible for providing a critical analysis of how the design and development of artefacts is carried out. There are two types of artefacts developed in this study: micro-learning deployment model and Ujuzi app. The artefacts are designed and developed from data collected during the identification stage. Some of the data informed the researcher about the characteristics and functionalities of the Ujuzi app. Also, other data were used to develop a deployment model as explained in chapter 7.

3.3.3.1 Development of the Ujuzi App

Before developing a mobile-based application, the crucial decision regarding the deployment approach is needed. There are three ways a mobile application can be deployed: through native applications commonly known as mobile apps, through web apps, and through hybrid applications. One of the key challenges of the native applications is their inability to operate in different environments, e.g. an Android application cannot operate in iOS, Windows or other operating system, and vice versa. Therefore, in order to make the right choice, developers use several criteria including interoperability, processing power, familiarity and accessibility to users. The situation analysis report provided the demography of mobile device ownership in the studied universities. Because it was realized that the extreme majority of students and academic staff use Android-based mobiles, we decided to develop a native Android app. Later we developed the web-based version of the app, a replica of the mobile version to allow learners to continue using the services even in times when they cannot access their mobiles due to several reasons including device malfunction. The two versions share the database in such a way that learners are able to access the same data regardless of what version of the application they use.

Several methodologies guide software and application development. The choice of a specific development methodology depends on several factors, including how able is the researcher to apply the chosen methodology? How much aware are the users with regards to the developed application? Moreover, how available are the users during the development stages? Because it was realized that users had little knowledge concerning brokerage and micro-learning services, the researcher decided to apply the prototype approach. The prototype is the recommended methodology for software and application developers in times when requirements are vague, and the development time is limited. Through prototype methodology, developers act on limited information to design and create the first prototype and present it to users. Next, users suggest some improvements to the initial prototype. Then,

developers use feedback to redesign and improve the initial prototype. After a number of refinements, after the agreement is reached, developers implement the last version into the actual system. Figure 3-3 describes the prototyping process. Also, the prototype approach is useful when you want to work together with users of the system; it is participatory and time-saving in most cases. In fact, the prototype approach fits very well in DSRM.

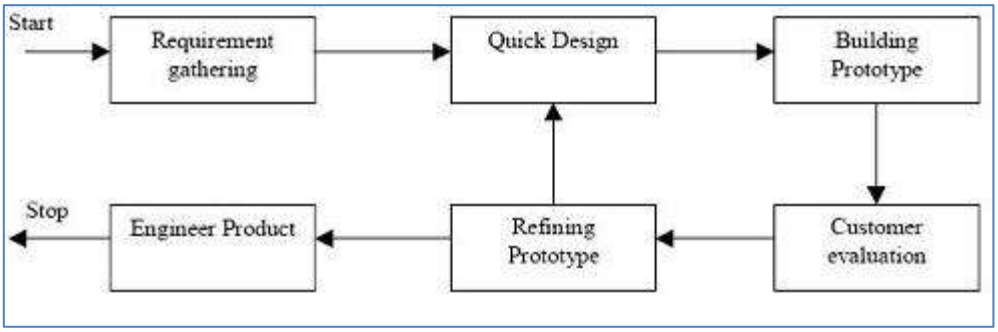

Figure 3-3: Prototyping model as adopted from www.Freetutes.com (10/10/2019)

In the present study, the researcher acted upon specifications obtained during the problem identification and produced the first mockup system by the aid of "Balsamiq Mockups" software platform accessible at *https://balsamiq.com/wireframes/*. I discovered the platform by searching Google for the best mockup tools. It is regarded among the best ten tools and offers rich technical features for designing both web-based and mobile-based applications (Aston, 2019). The Ujuzi mockup was evaluated by students and ICT experts as well as my supervisors before it was refined and later implemented. Figure 3-4 presents the first Ujuzi mockup screens before it was implemented. The final version of Ujuzi app can be accessed via the Google play store and its dedicated domain *www.Ujuzi.ac.tz*.

Upon completion, the two artefacts (the Ujuzi app and the deployment model) were demonstrated, evaluated and communicated to users and the general public as detailed in the proceeding sections. In chapter 6, we share the "*use case diagram*" of the Ujuzi app as one of the design outputs.

Figure 3-4: Balsamic mockup screens of the Ujuzi App

3.3.3.2 Development of the Deployment Model

The development of the model involved three main stages. First, we identified and explored factors that influence micro-learning success from literature. Then, based on the collected data from survey exploratory factor analysis (EFA) was used to identify the most collating factors and their respective items. Lastly, factors that qualified EFA were merged with the results of the qualitative analysis to obtain constructs used in the model. The detailed discussions concerning EFA processes are detailed in section 7.3 and annexe 7.1.

Second, the qualitative data were analysed to identify codes to be merged with the EFA factors. There are several ways that could be used to explore and analyze qualitative data including ethnography, netnography, and grounded theory. Specifically, netnography is a research method specific for studying cultures and communities online (Bowler, 2010). Because the focus was to understand the situation and then to produce theory based on participants perspectives, inductive approach and particularly, the grounded theory was chosen. Grounded theory is an inductive approach that leads to theory generation that relies on an understanding of the phenomena and then analyzes data by attaching codes, categories, theme and finish with theory (Harré & Langenhove, 1995). Then, the researchers establish not just concepts but also interrelationship of the identified concepts. Unlike other qualitative data analysis methods such as narrative analysis, with the grounded theory it is possible to

present the obtained theories diagrammatically through the use of symbols and notations as depicted in a model presented in chapter 7.

In this study, interviews were transcribed and securely stored in Google Drive, a cloud-based storage space from Google LLC, immediately after being recorded. In order to ensure data accessibility, the file-names and their organization observed common best practices. During analysis, data were loaded into NVIVO 14 software, reviewed in detail and assigned labels and concepts. Next, concepts were analyzed to identify themes that are the main constructs of the theory. Themes are described as general propositions that describe the relationships that exist between concepts. Through continuous comparison and by using theoretical sampling, the researcher was able to involve all needed participants until when the generated contents from the interviews were saturated. Upon reaching the saturation point, the researcher was able to achieve the required three-level of coding performed in grounded theory: open coding[5], axial coding [6]and selected (focused) coding [7]that bring about theories (Cohen & Crabtree, 2006). The final codes were merged with the factors from above to form constructs of a deployment model for micro-learning deployment in HEIs in Tanzania presented in figure 7.2. We present a critical analysis of a model in chapter 7 of this dissertation.

3.3.4 Artefact Demonstration

It is principally required to demonstrate the efficacy of the artefact to see if it can solve the intended problem(s). This process involves the use of appropriate methods such as experiment, simulation, case study and others. It is a democratic process that involves key stakeholders so as to judge how well the artefact addresses the problem as well as how well can it be used. In order to facilitate such a demonstration, the necessary documentation is provided to guide users on how to implement and apply the artefact (Gregor & Hevner, 2013; Gregor & Jones, 2007).

Both artefacts from this study were demonstrated to the general community and participants as follows. The Ujuzi app was first introduced at the "First International Conference on Innovative Education and Policy Reforms for Industrial Economy in Africa" at the University

[5] Open coding involves identifying concepts from the interviews transcripts. The concepts are the abstract labels that represent the incident(s), action(s) or event(s) from the studied phenomena (Corbin & Strauss, 1990).

[6] Axial coding involves organizing the concepts from open coding into categories and sub-categories.

[7] During selective or focused coding the high level concepts are identifies and then associated between each other to form a theory. Annex 7.2 depicts coding scheme of the study that produces a deployment model.

of Dodoma in November 2018 before being introduced again at the special workshop held at Mzumbe University in December 2018. Later, the app was used to support diploma and degree students at Mzumbe University. Also, the Ujuzi app was introduced at the poster presentation at the Groningen University in the Netherlands in June 2019. On top of that, the app was given public domain and uploaded to the Google Play Store for easy access by the general public. Students, ICT experts and academic staff at Mzumbe University sent feedback to the researcher for future improvements.

Similarly, the extracts of the micro-learning deployment model were published in two research papers (Ghasia, De Smet, et al., 2018a; Ghasia, Machumu, et al., 2018b). Also, the mock-up of the app was shared with some interview participants from all four universities for their inputs. This dissertation represents another communication media to expand the coverage and publication of the model and the app.

3.3.5 Evaluation Measures

The design science's rigor and relevance cycle require the publications and artefact to be rigorously evaluated (Hevner, 2004). In order to ensure rigorousness, it is vital to apply rigorous methods in domain knowledge. Researchers can use both quantitative and qualitative methods including frameworks and models that are approved in other fields such as mathematics, engineering, behavioural sciences and more (Gregor & Hevner, 2013; Gregor & Jones, 2007). For artefacts to be rigour, they should be implementable, flexible and present an acceptable knowledge (Gregor & Jones, 2007).

In order to ensure the quality of the two artefacts, the researcher applied the established and relevant qualitative and quantitative evaluation methods to establish the validity of the model and the app. Such evaluation measures include experts' opinions, member checks, as well as triangulation. In particular, the app was evaluated by the ICT experts, lecturers and students of Mzumbe University. The majority of those recommended the app that it shortens time to search for micro-learning units; it leads to skills improvement as well as enhancing access to quality content from reputable issuers. Similarly, the model was shared to the participants, experts and later presented in two conferences where we received positive feedback.

3.3.6 Communication

Together with the artefacts, DSR adds knowledge to the domain knowledge base. As described by Gregor & Hevner (2013) and Peffers et al. (2006) the design science researcher

should be able to communicate the output to both technical and managerial audiences. Practitioners need specialized instructions and guidelines on how to implement the artefact. On the other hand, managerial audiences need to be informed on the developments and potential business benefit by implementing the artefact (Dresch, Lacerda, & Antunes Jr, 2015). Managers need such information in order to make decisions to implement the artefact. The language and approaches to communicate the output need to be relevant for the intended audience so as to efficiently impact their attitudes. The common approaches used to publish the results are through publications to relevant scientific and professional journals, books, and theses and working manuals to professionals.

This research resulted in the publication of the aforementioned three research papers in reputable journals. Also, the results are presented in two international conferences as well as a poster presentation in two conferences. Similarly, the Ujuzi app was introduced to database courses for diploma and degree programs as well as a master degree course in education at Mzumbe University. The app is accessible via its dedicated domain and Google Play Store. Also, the web version of the app contains documentation on how to use the application. Even though it is not necessary for the artefact to be implemented for the study to be credible (Hevner et al., 2004), the author's commitment to making the app used goes beyond the completion of this project.

3.4 Research Ethics

Research ethics is an important and prominent aspect in all types of research, especially those dealing with people (Orb, Eisenhauer, & Wynaden, 2001). DSR, like any field, requires to observe ethical behaviour throughout the conduct of the work in which researchers are required to ensure privacy, anonymity, dignity of their participants. In order to ensure ethical issues are observed, different research communities, including universities, have formulated ethical principles that guide how research should be conducted within ethical boundaries. These principles provide a mechanism to protect both the researcher and other stakeholders (Neuman, 2011). In principle, ethics bodies ensure that before a research work is carried out, it must be reviewed to ensure it is relevant and that it conforms to the established principles. Therefore, any work that is deemed poor in ethical terms cannot proceed. However, the literature suggests that there are situations that occur during or after the study that cause an ethical dilemma, which is not included in the principles. In these situations, researchers and stakeholders are encouraged to respond to the challenges accordingly (Brownlow & O'Dell, 2002; Orb et al., 2001).

Ethical cases and challenges differ. However, there are common ethical behaviours that is promoted in all kind of researches including to seeking consent from participants, to obtain permission from the responsible entities, to accurately describe the study to the participants, to maintain privacy, confidentiality, and anonymity of the participants (Brownlow & O'Dell, 2002; Neuman, 2011; Orb et al., 2001). On top of that, researchers are required to deal with quality, integrity and objectivity of the study. The description and application of these principles are described in the next paragraphs.

The primary purpose of obtaining permission from the authorities as well as seeking consent from the participants is to protect both the researcher and participants. During the conduct of the research, especially if one is using methods such as interviews, survey, or observation, then participants expose themselves to potential harms. The information they provide might be sensitive about themselves, their society, as well as opinion about others, such as their bosses (Brownlow & O'Dell, 2002). Also, consent helps to improve the credibility of the results. It is believed that people are more likely to give credible information if they do so willingly and not through force. Therefore, participants need to be assured that their account of the study will only be used for the intended purpose and that they are protected. If the researcher fails to protect their participants, they will likely face backlash from society and hence destroy their lives to some degree. Also, the obtained permission from the authorities enhances confidence to your participants and protects the researcher from other unknown attitudes from the stakeholders, especially when there are elements of conflicts of interest. For sure, permission acts as a license to work freely within the respective environment (Neuman, 2011).

Unfortunately, several cases illustrate how researchers acted without obtaining consent from the subjects. For example, Orb et al. (2001) share a brief description of a doctoral-researcher who observed his homosexual participants for six weeks while working as a nursing auxiliary. There are similar cases in medical research where research about medicine and methods were carried out on patients through deceiving explanations. Similar situations have prompted a prominent ethical debate within digital anthropology studies (Brownlow & O'Dell, 2002), whether it is legitimate to study online societies while using hidden identity. The common view is that participants and subjects have the right to willingly and knowingly participate in the study (Boellstorff, 2012; Orb et al., 2001). Participants need to know the purpose and how the result will be used, including how it is going to impact society. The researcher has to describe the purpose of the study to their participants and authorizing bodies before the study is carried out. Also, it is the right of the participants to know about the

progress of the study from time to time and especially when the results are about to be published (Boellstorff, 2012; Neuman, 2011).

Another challenging concept of the research ethics is to maintain privacy, confidentiality and anonymity of the participant. Research works that are considered ethical tend to hide the identity of the organization and participants. It is essential to ensure that the content of the study report does not lead to identify or disclose the identity of those involved in the study (Orb et al., 2001). In the case of the apparent description of situations that leads to disclosure of identity, the consent from the participants or subjects should be sought. The common practice is that researchers use aliases instead of the actual names. However, such an approach is not sufficient when the study area and people are obvious (Neuman, 2011).

Other challenges that cause dilemma include dealing with quality, integrity and objectivity of the study. It is expected that the researcher will collect, analyze, and present results in a way that guarantee quality due to the methods used, a way they have dealt with subjectivity issues, as well as controlling their personality from interfering with their studies (Neuman, 2011; Orb et al., 2001). When there are situations that challenge the integrity of the study, for example, if the study is carried out in the environment where the researcher works, there should be a description about how they handled the case of bias. Moreover, if there is a conflict of interest among stakeholders, the description of the situation should be disclosed. One way to address integrity issues is by having quality study design and protocol that ensures that there is no bias in selecting participants as well as giving a fair chance to participants to express their perspectives.

Sensitive to the ethics principles, we approached the project by seeking permission from the universities through an introduction letter sent by Mzumbe University. Upon permission to conduct data collection, the researcher used the introduction letters from the respective university to her subordinate university organs to seek consents from the participants. Apart from UDOM who asked the researcher to sign for ethical clearance before the start of the project, all other sites did not have additional processes. The participants at their environments (offices, hostels and areas) were informed about the purpose and motives behind the study and asked to participate. Also, they were assured of the privacy, confidentiality as well as the integrity of the work. We were also permitted to record the interviews and to use their actual names if needed in the reports of which we did not do. During the data collection phase especially, after each interview, participants were given a chance to verify the content of the interviews before they became publishable materials.

Moreover, in order to ensure the integrity of the work, the interviews, as well as survey data, are well organized and securely stored by using best-known practices, including the use of standard file-names. Also, the names of the respondents are omitted from all the published works to protect them from any possible danger. The permission letters from the universities are attached as annexe 3.1**.**

3.5 Limitations and Delimitations of the Study

Any research is bound to have its limitations in terms of the nature of the problem and the conditions under which the work is carried out. The present research had several limitations that were adequately tackled to ensure that the objectives of the research are met, as described below.

The first limitation is related to the respective university schedules. It was realized that the original timing for data collection we had prepared was against the university calendar. When we visited the universities, students were in their extended vacation from June to October of every year. The usual tradition is that during such a period, the majority of the academic staff also works from homes. Due to that, we had to reschedule the data collection activities to some sites until when students ended their breaks. Similarly, for academic staff, we embarked in employing research assistants from respective universities to facilitate the process of reaching and organizing interviews whenever possible. In addition, during the survey exercise there were some challenges, especially to get the survey forms back from some academic staff because they occasionally worked in their university offices.

The second challenge was to get permission to conduct the study. While the process to get permission seems straightforward as stipulated in the previous section, the reality is that it took more than three months to receive feedback. In one occasion, I had to resubmit the application letter twice and visit the institution three times before receiving the permission later. All these affected in terms of schedule, budget and flow of related activities.

The third limitation is related to the fact that micro-learning is a new concept; the majority of the respondents seemed to be unaware of the concept. That necessitated the researcher to explain the concept and project in details to some of the participants, which lead to the delay of the project. Also, due to the novelty, it was hard to attract many lecturers to join Ujuzi testing with their subjects. Therefore, we decided to narrow the testing to fewer subjects. I appreciate lecturers from the Faculty of Science and Technology as well as Faculty of Social Sciences Education at MU who accepted the Ujuzi app to be used by their students.

The earlier mentioned difficulties represent some major limitations that we faced during data collection and analysis phase, but the researcher was able to find alternative ways to address them. In the end, the existence of these setbacks did, in our opinion, not jeopardize the overall execution of the project. Hence, we are confident that the outputs of this work are credible and reliable.

3.6 Chapter Conclusion

As previously described, micro-learning deployment is the techno-socio-pedagogy project that bank on the people to share and explore their phenomena and devise strategies to improve the situation or solve the identified social problems. Because the focus of the study was to produce both artefacts and design knowledge to the knowledge domain, the Design Science Research Methodology was ideal for the project. The present chapter provides a detailed explanation of the processes performed for the sake of achieving the intended objectives. Specifically, we have demonstrated and implemented DSRM in the context of this study. Through the use of Hevner et al., (2004)'s framework and Peffers et al (2006)'s process model, we have developed an adequate intervention to solve the problem as well as bridging the research philosophy and the actual conduct of each activity. It is with this confidence that we believe the results obtained from this methodology are credible as presented in the coming chapters.

CHAPTER FOUR

MICRO-LEARNING AND THE HIGHER EDUCATION INSTITUTIONS IN TANZANIA

4.1 Introduction

Our discussions concerning micro-learning and micro-credentials in chapter 2 of this dissertation highlighted the importance of both concepts in improving skill-based learning. Due to the scarcity of literature concerning the aforementioned two areas of research about Africa and Tanzania in particular, this chapter reveals the state of micro-learning as well as micro-credentials in HEIs in Tanzania. Grounded in the Critical Theory of Technology, the Connectivism learning theory and the Design Science Research, we combine the findings of the situation analysis conducted in the four Tanzanian universities with the secondary data obtained from the reviews of literature and strategic documents. Specifically, we explore issues related to challenges and readiness as reflected in the research framework in chapter 2 (*items 1&2 in figure 2-1*).

Significantly, the findings and recommendations outlined in this chapter form the base for the coming discussions concerning the challenges (chapter 5) and a deployment model (chapter 7) as well as the Ujuzi app implementation (chapter 6). Also, we expect the findings and recommendation from this dissertation to help practitioners, decision-makers as well as researchers in both aforementioned research areas. Particularly, the content of this chapter addresses the first research objective of this study "*To explore the status of micro-learning and micro-credential implementation in the HEIs in Tanzania*".

The chapter is organized as follows: it starts with this introductory remark in *section 4.1* before proceeding to the background information in *section 4.2*. Within the background information, we critically present the state of ICT as well as e-learning adoption in the universities. Then, in *sections 4.3&4.4* we descend into discussions concerning micro-learning and micro-credentials respectively. Further, *section 4.5* provides a critical examination of the policies in HEIs. Then, we share lessons learned in section 4.6 before concluding the chapter with a summary in *section 4.7*.

4.2 Background Information: Picturing the Tanzanian HLI scene

According to the Tanzania Commission for Universities abbreviated to TCU, as of 4th February 2019, the Tanzania Higher Learning Education (THLE) is comprised of thirty-four full-fledged universities, of which twelve are public and twenty-two are privately owned (TCU, 2019a). Also, there are fifteen university colleges, of which three are public and twelve are private (TCU, 2019a). On top of that, there are two university campuses and one institute as well as six privately-owned centres. The overall responsibility of managing the HEIs in the country is entrusted to the TCU as reflected in all official documents of the commission and quoted hereunder (Ishengoma, 2016; TCU, 2019):

> *"(TCU) is a body corporate established on 1st July 2005, under the Universities Act 2005 (Chapter 346 of the Laws of Tanzania) with mandate to recognize, approve, register and accredit Universities operating in Tanzania, and local or foreign University level programs being offered by registered higher education institutions. It also coordinates the proper functioning of all university institutions in Tanzania so as to foster a harmonized higher education system in the country."*

On top of performing the above regulatory functions, the TCU has an advisory role to the government and general public on all issues related to higher education including formulation of relevant policies and strategies (TCU, 2019b). Moreover, it provides necessary support and guidelines to institutions under her mandate to ensure that they operate in accordance with the set standards to ensure the quality and sustainability of services.

Besides, the TCU is entrusted to ensure that Tanzania is equipped with the right amount of skilled human capital that ensures sustainable prosperity in all sectors of lives. Likewise, it is the responsibility of the TCU to spearhead innovations and research activities within higher learning and research institutions (TCU, 2019b). Specifically, TCU provides guidelines and standards that ensure the majority of qualified Tanzanians get the chance to join universities of their choice (TCU, 2019b). Currently, it is revealed that 63,737 students joined the HEIs in the academic year 2017/18 (TCU, 2018b). In order to ensure quality of services in the institutions, the TCU conducts periodic audit and monitoring exercises (TCU, 2019b).

Nevertheless, despite the efforts done by the government and the TCU in collaboration with partner institutions globally, the situation in Tanzania higher learning education is

not very different from the rest of the developing countries. As described by Ishengoma (2016), HEIs in Africa faces a number of challenges including the rapidly increasing number of enrolled students, lack of key competencies in specific subjects including mathematics and engineering as well as the availability of an unsatisfying quantity and quality of facilities and infrastructure. Subsequently, it is widely reported that the majority of the institutions of higher education have a limited number of qualified academicians to cope with the increased number of students (Mtebe, Dachi, & Raphael, 2011; Nagunwa & Lwoga, 2012). Consequently, the number of enrolled students surpasses the capacity of available facilities and infrastructure. For example, it is reported that computer-student ratio at MUHAS, MU and UDSM exceeds 1:50 (Mtebe et al., 2011; Nagunwa & Lwoga, 2012). Truly, the over-enrolment of students has become a burden to the academic institutions, especially the academic staff and infrastructure. We are witnessing over-crowding classrooms, over-utilized academic staff, as well as overloaded network and Internet spaces (Ghasia, De Smet, et al., 2018a). Other challenges include limited access to quality learning resources.

The unsettled academic environment filled with frustrated educators and students is a challenge to quality delivery learning experiences (Nagunwa & Lwoga, 2012). In particular, institutions in Tanzania are forced to produce coping strategies to enable them to deal with the current situations. For example, Mzumbe University in 2006 introduced staggered semesters to accommodate additional students and established Mbeya and Dar es Salaam campuses (Baelden, Musabila, Van Audenhove, & Bizyuk, 2014). Also, UDSM opted to establish distance-based courses that run through mediated technologies (Mtebe & Raphael, 2017). Similarly, MUHAS has established competency-based medical courses through mediated technologies (Nagunwa & Lwoga, 2012). These three examples are just snapshots of the strategies employed by the HEIs. Similarly, to respond to the increased number of students who join the HEIs as well as tackling the limited number of science teachers, the government of Tanzania established new universities including the UDOM and the Nelson Mandela African Institute of Science and Technology (NM-AIST). Other efforts include the establishment of the Higher Education Students' Loans Board (HESLB) to ensure many students are able to join universities and learn regardless of their financial statuses (TCU, 2019b).

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4.2.1 The Rise of Information and Communication Technologies (ICTs) in the HEIs in Tanzania

As described in the second chapter of this document, advances in information and communication technologies and systems is transforming our ways of doing things in all sectors of lives (Ghasia, De Smet, et al., 2018a; Lashayo & Alkawaz, 2005). Universities across the globe are leveraging from these developments to improve their reach and quality of services (Lashayo & Md Johar, 2018). Likewise, the HEIs in Tanzania are leveraging from these technologies to both benefit from the prevailing potentials as well to cope with the challenges identified in the previous section (Adomavicius, Bockstedt, Gupta, & Kauffman, 2008; Lwoga, 2014). For example, to address issues related to the administration of the institutions, all institutions own websites to communicate their services to the general public (TCU, 2018a). Within the websites are the links to the specific information, services and contacts (TCU, 2018a). Also, the use of multimedia technologies in the lecture rooms is common in Tanzania (Mtebe & Raphael, 2017). On top of that, all the universities have deployed ICT infrastructures and technologies to students and educators (Mtebe & Raphael, 2017; Nagunwa & Lwoga, 2012). They include computers, servers, networks and access to the Internet (Mtebe et al., 2011).

In addition, developments in the area of ICTs and HEIs correspond to the deployment of technologies that facilitate teaching, learning, research and consultancy (Jaffer et al., 2007; Makunja, 2016). These technologies include learning management systems (LMS), library systems for the provision of online public access catalogue (OPAC) services as well as institutional repositories (IR) (Lwoga, 2014). Previous studies indicated that the majority of Tanzanian institutions have installed LMS of various types including Moodle, Blackboard or TUSK (Nagunwa & Lwoga, 2012). However, Moodle is the most deployed system because it is open source, have a strong support community as well as it is freely available compared to the rest (Mtebe & Raisamo, 2014). In particular, all top-ranking universities in Tanzania, UDSM, UDOM, OUT, MUHAS and MU have deployed Moodle and Dspace, software for managing institutional repository for over a decade. However, despite all the efforts done by the institutions, scholars report under-utilization of such services due to various reasons (Mtebe & Raphael, 2017).

Likewise, as reported in chapter two, the high proliferation of mobiles has prompted various academic institutions to explore and leverage from the ubiquitous technology to offer learning “anywhere” and “anytime”. Despite the reported high mobile ownership by students

and educators in the HEIs in Tanzania, studies reveal low uptake of m-learning in higher learning institution in Africa and Tanzania in particular (Ghasia, De Smet, Machumu, & Musabila, 2018a; Isaacs & UNESCO, 2012). In fact, mobiles are said to liberating and empowering students and academic staff who could not buy to own computers (Chambo et al., 2013). Mobiles installed with social media networks such as Facebook and WhatsApp have become the main communication media in the universities, they facilitate information exchange, announcements and collaborating activities (Baelden et al., 2014). For example, at Mzumbe, class representatives use social media to communicate class cancellations, meetings and all issues related to the academics (Baelden et al., 2014). Likewise, at the UDOM, especially the College of Education, due to the lack of an enabling infrastructure for the Internet, mobiles have become the saviour as described by one of the respondents during the interview session "*I use it [smartphone] quiet often. I forward my books into my smartphone. You go www.youtube.com you watch clips. You might listen to the lecture [in the class] and fail to understand, but you get clips, you easily understand." (Male, UDOM, 25, 12/03/2017).*

These situations are not unique, similar situations exist in all HEIs including the UDSM and MUHAS as revealed by Mtebe (Mtebe & Raphael, 2017) and (Nagunwa & Lwoga, 2012) respectively. No wonder, these platforms were highly ranked by the students during the Mfunzi development process at Mzumbe University (Baelden et al., 2014). At the same time, the spontaneous searches on generic platforms like YouTube raise the question of efficiency and adequacy selection of clips by the students. Through Ujuzi app the contents are filtered to ensure quality to the learner by the trusted providers and Ujuzi team.

Significantly, it can be realised from the literature that technological deployments in the HEIs has not managed to transform the ever-present traditional systems of academic delivery. We commit no offence to claim that the HEIs in Tanzania are in a liminal state, at the ambiguous stage, in between modern and traditional (Uimonen, 2012). Nevertheless, much of the activities related to the application for enrolment and dissemination of students' results are shaped with technologies (TCU, 2019b). At the same time, there exist contradicting policies within these institutions. For example, while policies and strategic objectives of one of the institutions stress "at least 50% of the courses available online", the student by law of the same institution forces students to attend traditional face-to-face sessions for at least 80% in order to be eligible for the final examinations. At the same time, lecturers are forbidden to issue online examinations to students. Subsequently, faced with these uncertainties, lecturers prefer a blended-based approach to deliver technology-based learning to complement the

prominent face to face approach (Makunja, 2016). There are very few full online courses issued by the institutions of higher education in Tanzania. The situation is not different today in 2019.

Unfortunately, despite the recurring and hyped need of decolonizing African knowledge, the deployment of ICTs systems in Tanzania higher learning institution demonstrate high dependency on foreign interventions ranging from technology, finance, capacity building as well as deployment approaches. To date, all the underlying technologies including LMS, Web 2.0 services, institutional repositories and the Internet are foreign. We are yet to witness real African solutions in the universities. Or might the customization done by local programmers be enough to claim the existence of African innovation and experience in science (Mavhunga, 2017)?

We argue that much is expected from HEIs entrusted to liberating the continent from being the planetary laboratory for imported goods and technologies. Also, institutions are still relying on foreign aid to inspire and deploy technology-enhanced learning (Mtebe & Raphael, 2017; Nagunwa & Lwoga, 2012). For example, Mzumbe university infrastructure has a long history of foreign support from UNDP, NTP, and VLIR-UOS just to name few. In particular, VLIRUOS is building capacity to staff, adding network equipment, servers and wireless access points. Also, UDSM, MUHAS, UDOM are benefiting from foreign support for technology and capacity building as described by (Ishengoma, 2016).

4.3 Micro-learning and the Higher Education Institutions in Tanzania

In the previous section, we have demonstrated the status of e-learning and mobile-learning deployments in the Tanzanian HEIs as well as showing how they are applied. Because, micro-learning is a new learning approach across the globe, there are limited literature concerning the status and their application in Tanzania HEIs. Therefore, we conducted a situation analysis concerning the deployment of micro-learning in these institutions. Specifically, the analysis aimed to uncover stakeholders' awareness and experience with micro-learning concepts. Also, we wanted to uncover the availability and accessibility of the micro-learning services by using institutions' infrastructures. On top of that, we explored the attitude of the academic stakeholders towards micro-learning and its associated concepts.

4.3.1 Instruments and Participants

As described in the methodology chapter, combinations of methods were used. They include a survey that involved 172 students, 41 lecturers and 19 education technologists from the four

universities in Tanzania. On top of that, strategic documents such as policies and examination bylaws and websites were studied to identify relevant information related to the study. In addition, in-depth interviews were carried out to 53 students, 30 lecturers, 9 technologists and 8 members of the management team who are in charge of deployment and overseeing the deployments of technology-enhanced learning. The survey and interview guide are attached as annexes 4.1 and 4.2 respectively.

4.3.2 Data Reliability

For the survey data to be credible, it is recommended to conduct reliability analysis of internal consistency of a Likert scale before that scale can be translated into actual research findings (Gliem & Gliem, 2003). There are several measures of internal consistency including Split-half and coefficient alpha also known as Cronbach's alpha (Streiner, 2003). Of the two measures, the later is widely used to measure internal consistency of Likert scale because it is more reliable and convenient to use as it requires a single test only to obtain desired results. In principle, the coefficient alpha is the mean value of reliability one would obtain after carrying out the same test for a number of time (Gliem & Gliem, 2003; Streiner, 2003). Normally, the value of the alpha ranges between 0 and 1, however, there are cases when the value fall to negative (Gliem & Gliem, 2003; Streiner, 2003). The acceptable rule of thumb is that all scores above 0.6 are acceptable to allow researchers to have a true reflection of the score for the scale (Gliem & Gliem, 2003). In practice, during analysis, if some questions are not well correlated with the rest, they are removed to improve the consistency level of the data.

In this work, we applied coefficient alpha to analyse the reliability of the internal consistency of the six scales too for each category of respondents: technologists, students and lecturers. These scales are linked to the research framework concerning issues related to readiness, challenges and factors related to success (figure 2-1, items 1, 2&3). The first scale concerns with determining the awareness of the respondents towards micro-learning. The second scale concerns the experience of the respondents in relation to micro-learning. The third scale concerns with frequency to which respondents access micro-learning services whereas the fourth scale is about the availability of micro-learning services at the institutions. The fifth scale concerns the accessibility of micro-learning services by respondents. And the last scale measures either negative or positive attitude of the respondents towards micro-learning. The tests were carried out successfully, with minimal modifications to the items within specific scales to ensure reliability as following:

The items 4&5 of the fifth scale (accessibility), as well as the item 3 of the sixth scale (attitude), were removed from the technologist data because they failed the test as required and practised (Gliem & Gliem, 2003; Panayides, 2013).

The items 4&6 of the second scale (experience) and the items 2&4 of the fifth scale (accessibility) as well as item 3 of the attitude scale was removed from students' data.

Likewise, item 6 of the second scale (experience) was removed from lecturers' data. On top of that, all data concerning the accessibility scale for lecturers were removed as they were deemed not consistent enough. That means we rely on the consistent data from the students and technologists to provide insight concerning the scale. However, the loss of educators' data is compensated by the interviews data conducted to the educators.

S/N	Scale (#of items)	Students	Lecturers	Technologists
1	Awareness	.86	.94	.89
2	Experience	.73	.86	.88
3	Frequency	.86	.83	.77
4	Availability	.73	.85	.83
5	Accessibility	.75	Nil	.73
6	Attitude	.85	.80	.86

Table 4-1: Results of Cronbach's Coefficient tests

The table 4-1 above provides the summary results of the reliability test performed against the data used in the analysis of this chapter.

4.3.3 Discussions of the Results

In this section, we provide detailed discussions of the situations in the four Tanzanian universities concerning micro-learning deployments. These results are from the survey, documentary review as well as an in-depth interview with lecturers, students and educational technologists. Significantly, the discussions in this section influenced our choices of technologies and deployment approaches as discussed in the proceeding sections.

4.3.3.1 Awareness of Micro-learning in HEIs

Based on the survey data, there is good awareness of micro-learning and its associated services by the students compared to the educators. Overall, 35% of the educators and 65% of students have both indicate that they are aware of micro-learning (figure 4-1). Specifically, they are aware of the concept and the associated benefits (figure 4-2). Also, they perceive micro-learning as the most disserving pedagogical approach for their situation (30%, 63%) (Figures 4-3). On top of that, the majority of the students feel that the design and duration of the micro-learning session is vital for the success of the projects. In addition, 79% of

technologists are aware of the micro-learning approach as well as its associated benefits (70%)

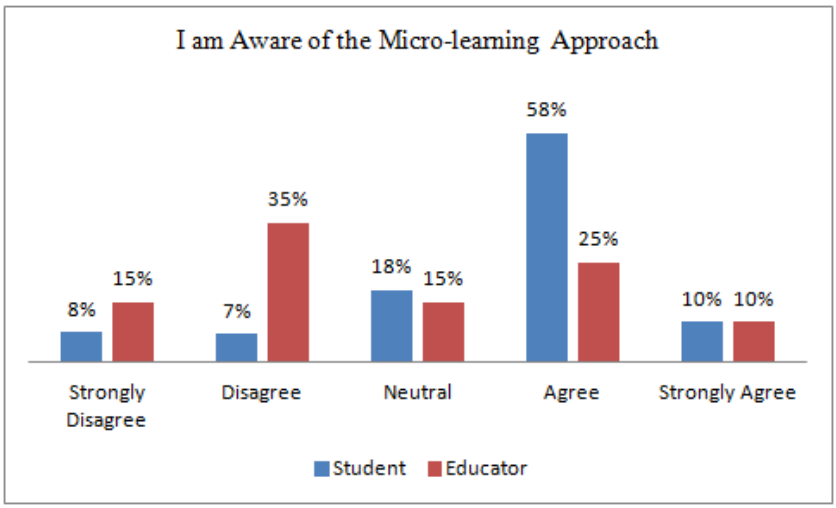

Figure 4-1: Micro-learning Awareness

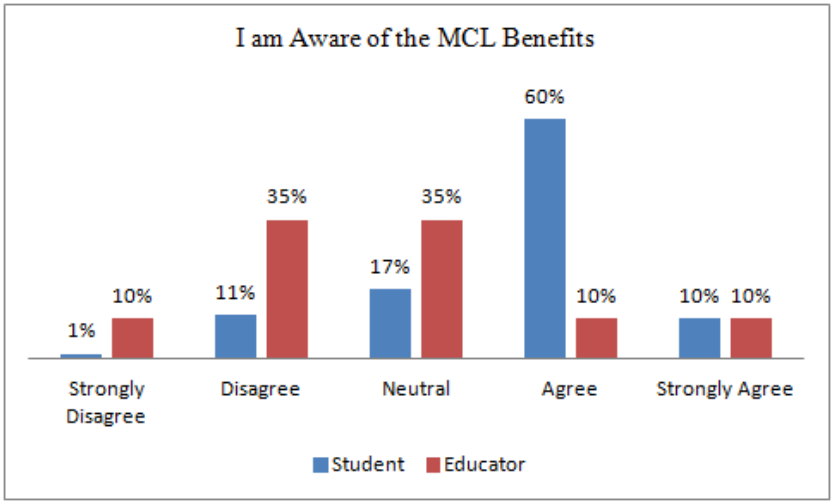

Figure 4-2: Awareness of micro-learning benefits

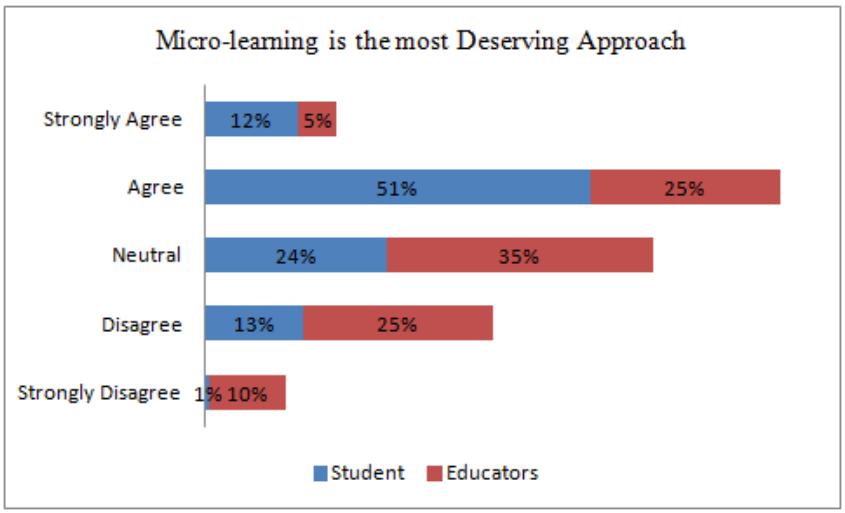

Figure 4-3: HEIs deserves Micro-learning Approach

4.3.3.2 Experience with Micro-learning

Apart from indicating their awareness of micro-learning concepts, the respondents were requested to share their experience with micro-learning services. Specifically, we wanted to know to what extent respondents are involved in learning, issuance or supervision of micro-learning services within or outside their institutions. Both, the awareness and experience of the respondents with regard to micro-learning services are important in shaping our choices of technologies, approaches as well as development of a micro-learning deployment model.

Regrettably, the overall experience of the respondents with respect to micro-learning services is very low. Results indicate while 57% of the students indicated having micro-learning experience, 50% of the lectures lack micro-learning experience (figure 4-4). Similarly, it is revealed that 48 % of the technologists and 65% of lecturers lack the necessary skills to prepare micro-learning content. In addition, while 58% of the technologist indicated to not have participated in offering micro-learning, only 25% have indicated to have recommended micro-learning content to students. On the other hand, a good number of students (62%) have indicated that they often use micro-learning videos from www.youtube.com. On strong note, 33% of the students believe that it is impossible to learn through mobile devices such as smartphone [referring to the current mobile learning content].

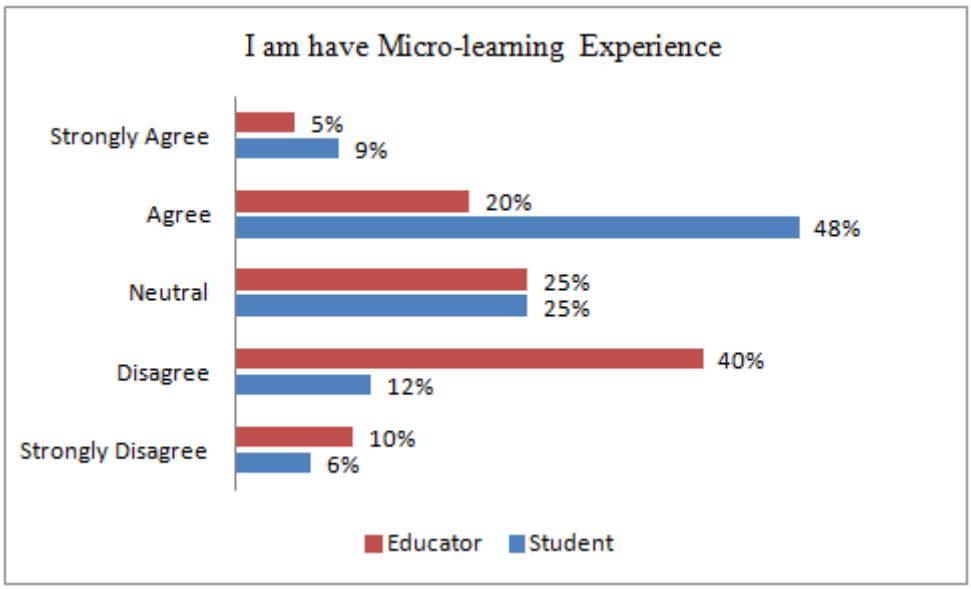

Figure 4-4: Reaction concerning micro-learning experience

4.3.3.3 Availability of Micro-learning Services

Particularly, we wanted to learn from the respondents on the capability of the institutions to own and offer micro-learning services. Specifically, we needed to know if there were adequate infrastructure and support systems in the institutions. Likewise, we wanted to identify the existing local issuers of micro-learning services. This kind of information helps to understand the status of micro-learning deployment in Tanzania higher education institutions.

Results indicate the lack of micro-learning services and capacity in Tanzania HEIs. In particular, the majority (74%) of technologists, who are in charge of systems deployments, 65% of the lecturers and 67% of the students deny the availability of Tanzanian based micro-learning services providers including HEIs (figure 4-5).

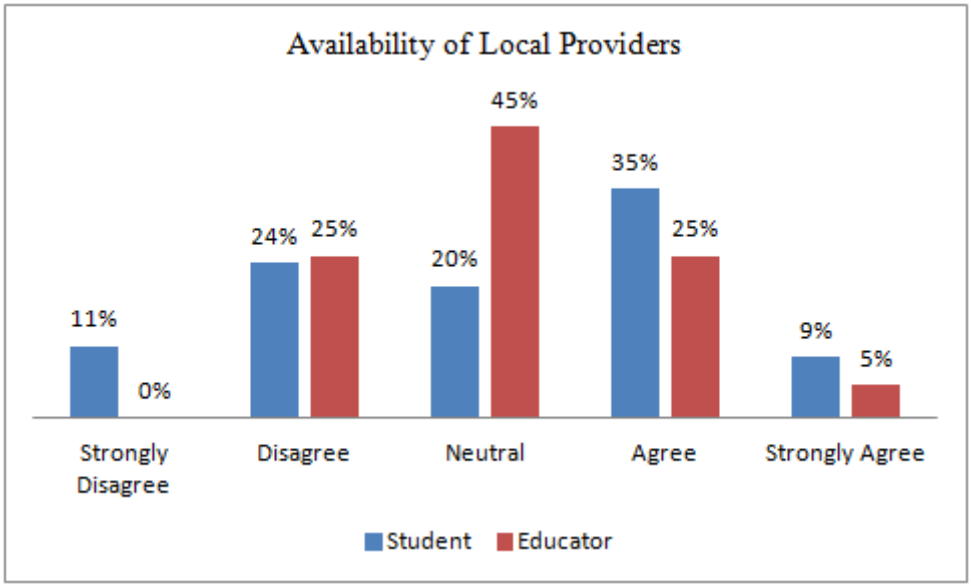

Figure 4-5: Reactions to the availability of local providers

Also, only 21% of the technologists, 20% of the lecturers and 33% of the students believe that their universities are working to integrate micro-learning contents into their courses (figure 4-6). Also, only 42% of technologists believe that their universities host satisfactory infrastructure and support services for micro-learning services. However, 65% of the lecturers supplement their learning experience with micro-learning videos from the Internet. Likewise, the majority of the respondents are not aware of any local issuers of micro-learning services.

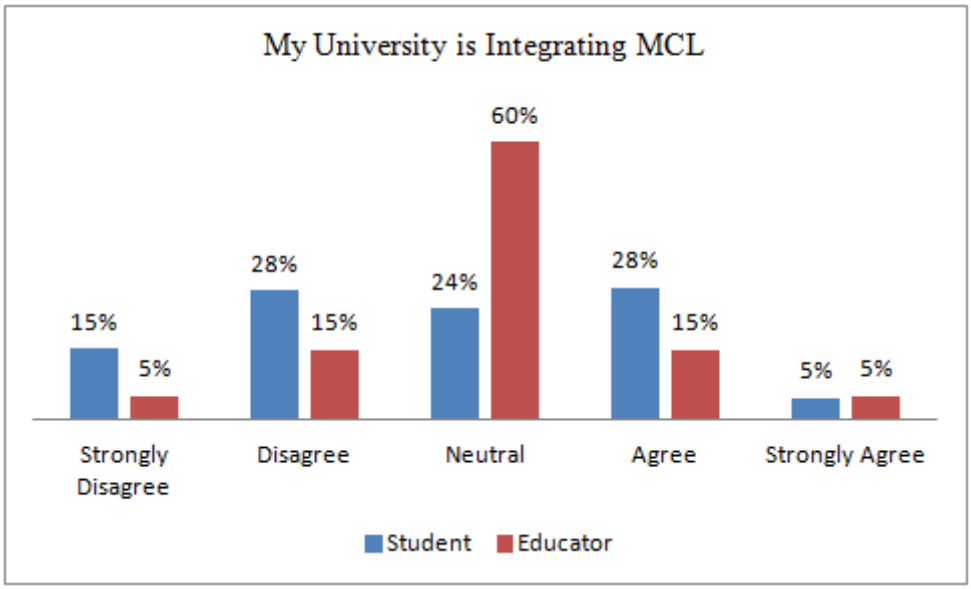

Figure 4-6: Micro-learning integration in HEIs

4.3.3.4 Accessibility of Micro-learning services

In order for micro-learning services to flouring, learners need to be able to access services from anywhere and anytime (Kadhem, 2017). That necessitates the issuers to publish micro-

learning content in an accessible infrastructure from anywhere in the world. Particularly, the platforms should be accessible through both mobiles and computers. Respondents were required to describe their situations in relation to accessing institutional micro-learning and other learning services. By so doing, the scholar was able to deduce information concerning the situations at the universities in Tanzania. Regrettably, we were unable to process survey data corresponding to the lecturers for this scale because they were inconsistent as explained in the preceding section.

Generally, both technologists (58%) and students (55%) feel that there are poor conditions in the universities with regards to micro-learning access. More confusion arises when 79% of the technologists claim that universities offer enough connected computers to access online contents, whereas only 40% of the students agree with such a claim. Also, while only 21% of the technologists believe that you need to be at the university to access university services, 52% of the students believe otherwise. Moreover, 62% of the students and 58% of the technologists believe that paying for the mobile Internet is not a problem. More significant, only 58% of the technologists believe that Wi-Fi services at their universities are sufficient to access online services. No wonder, the technologists' score is consistent to that of students; only 50% of the students feel that the university infrastructure fulfils their needs to access online resources.

4.3.3.5 Attitude towards micro-learning

It is important to understand the attitudes of the users of a particular service or technology because, attitudes determine usage (Rogers, 2002). It is revealed that negative attitudes towards technology negatively influence usage (Lee et al., 2003). In particular, if users perceive a certain technology or innovation have positive effect to their works or lives, they will likely use such innovations, and vice versa is true (Venkatesh et al., 2003).

Specifically, we wanted to know the attitude of the respondents towards philosophy behind micro-learning and if they are willing to extend the reach of micro-learning to their friends. Likewise, we needed to know if they find micro-learning as relevant pedagogical approach for lifelong learning. In the end, we were interested to hear their commitment towards participation in preparation, issuance or purchasing micro-learning services. These questions are ideal when it comes to setting relevant strategies for technological deployment.

Overall, the results indicate good attitude towards micro-learning deployment. This revelation is consistent with previous studies (Polasek & Javorcik, 2019; Steinbacher & Hoffmann,

2015; Zhao, Xia, & Zhu, 2010). Specifically, 68% of the technologists, 75% of the lecturers and 75% of the students have a positive attitude towards micro-learning. One area of interest is the micro-learning philosophy; results reveal that 84% of the technologists, 65% of the lecturers and 68% of the students are positive about it; however, we cannot ignore almost over 20% of the neutrals (figure 4-7). Furthermore, 65% of the lecturers and 74% of the students are willing to recommend the use of micro-learning services in all sectors (figure 4-8). On one hand, 79% of the technologists and 65% of the educators are willing to participate in offering "free" micro-learning contents. On the other hand, 84% of the technologists and 65% are of the educators' opinion that, if the opportunity arises, they are willing to prepare micro-learning contents for sale of which 75% of students are willing to purchase.

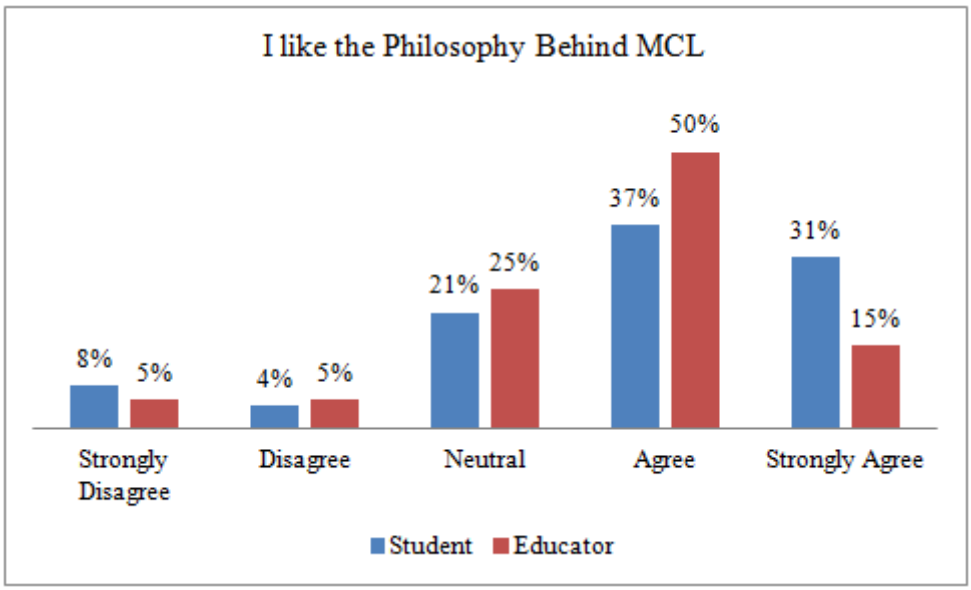

Figure 4-7: Reaction towards micro-learning philosophy

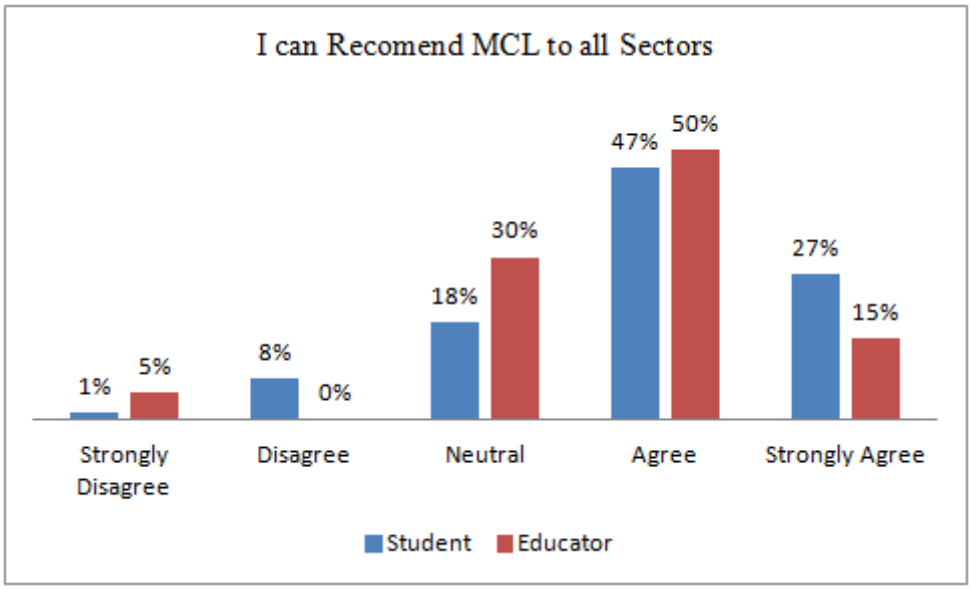

Figure 4-8: Attitude towards micro-learning

In particular, students indicated that micro-learning is relevant to them as it allows them to work anywhere and anytime by using their mobiles. On top of that, having the content that focuses on a single specific learning objective makes learning easy to comprehend as well as it saves time. In one of the interviews, one of the students responded like this *"here we learn everything, this lecturer sends you eighty slides, another sends you a hundred slides, and you have to do practically. That is why we are seen shallow [lacking specific skills]*" (Male, 26, MU, 20/09/2018) the figure 4-9 below provide details of students' reactions towards micro-learning.

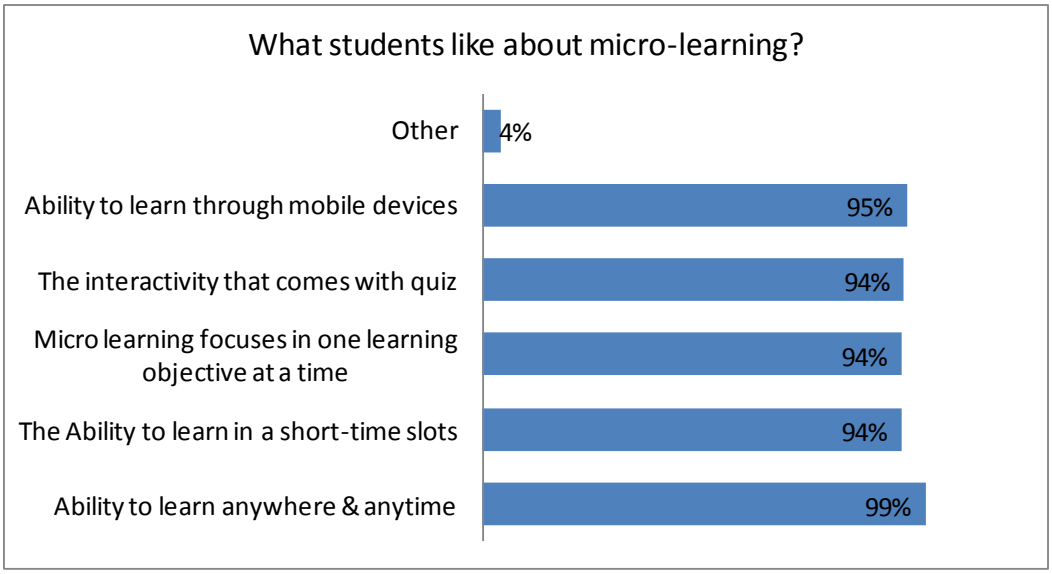

Figure 4-9: Students preference of micro-learning

4.4 Micro-credentials in the Higher education institutions in Tanzania

In the sections above, the state of e-learning and micro-learning in HEIs in Tanzania are presented. In this section, we devote into discussions concerning the related concept as we have introduced in sections 2.7. Due to the prospective future of micro-credentials in educational and professional development as a whole, and because of the lack of literature concerning the state and their application in HEIs in Africa, this section presents results of the situation analysis conducted in aforementioned four universities in Tanzania concerning the state of micro-credentials in the country. In fact, the results and contents presented in this section are the extracts from the paper published in the International Journal of Education and Development using Information and Communication Technology (Ghasia, Machumu, et al., 2018b). It is important to note that due to the novelty, and lack of enough individuals who are

conversant with the topic, a qualitative approach was preferred so as to understand the phenomenon clearly.

4.4.1 Awareness of Micro-credentials

The success of the micro-credentials' deployment depends on how much stakeholders are aware of and able to participate in the process. They include an understanding of the concept and philosophy behind micro-credentials as well as the procedures and processes needed to manifest the project. Our results suggest that micro-credentials are a relatively new concept across the studied universities. Unlike the traditional credentialing system, most of the respondents seem to be unaware of any system which is different from the traditional formal systems as attributed by the respondent in the text below:

> *"To say the truth, it is the first time I hear about your topic [micro-credentials]. I know the issue of skill recognition is not new but making it formal [process within universities] I hear it from you. But thinking critically, it is a good thing and beneficial to especially youth" (Male, 45, UDSM, 5/11/2018).*

Despite the majority of the respondents being aware of the badge concept used in the military and among scouts, very few have come across the term digital badges. Also, there is little understanding of the issuers as well as processes used to earn or issue digital badges. While the logic behind micro-credentials appears to be appealing in the mind of most of the respondents, fewer have attempted to earn or issue digital badges.

Similarly, it is revealed that none of the studied universities is contemplating the issue of micro-credentials due to a number of reasons. Educators and students speculate that the designs of the courses are not geared towards skill-based outcome, and it is unlikely that educators may venture into micro-credentials. Also, over-reliance on the traditional teaching system makes it hard for educators and students to shift focus into other forms of learning to complement the materials learnt in class. Also, due to the lack of awareness, the majority of the employers and admission officers ignore any credits that are not recognized as a formal credentialing system. Unless there is a change of strategies, policies and procedures to promote the alternative credentialing system, digital badges and micro-credentials will remain sidelined.

4.4.2 Readiness towards Micro-credentials

The second important aspect of deploying a new system into an organisation or society is to check whether the environment is ready. Readiness tests are physical and logical. They include questions related to the preparedness of the individuals as well as society as a whole, infrastructure, policy as well as individuals' skill and attitude. Despite, being new, we asked educators as well as students questions to find out how ready the institutions are as well as individuals towards micro-credentials and digital badges. First, skill readiness is essential to the successful deployment of any system. They include the ability to navigate through the digital media to perform required tasks, to set required micro-credential infrastructure as well as the ability to evaluate and accredit relevant skills to the respective learners.

Our results reveal that situations at the universities are encouraging to start the project. In all four universities, digital awareness amongst students and educators are high. The majority of the students and educators are conversant with the Internet and social media services. They use the Internet to communicate, search scholarly resources as well as to entertain themselves. In addition, three of the four universities have units entrusted to realize digital transformation. However, there are some skills gaps among educators and ICT experts that can be filled through short courses as attributed by the respondent in the text below and a sample of responses from the interviews is provided in the extract below.

> *"First, some lecturers are of the other generation that when you bring technology to them is a challenge. We want to reach a time when we can supervise students through soft-copy, but some [lecturers] respond [to us] that I cannot deal with soft-copy. So, we are of two categories: those who cannot work with technology completely and those who are trying to cope with it" Female, 45-50, OUT, 11/02/2017).*

Infrastructure is the backbone of the systems implementation. Digital badges rely on the functioning network and Internet systems as well as databases. Connectivism learning is a network forming process. Learners and educators connect and collaborate with various learning nodes across the Internet. The fluidity of the Internet is brought by bandwidth capacity and Wi-Fi connectivity. Also, micro-credentials rely on the ability to learn across the network. Unfortunately, the quality of the Internet services in all the universities is low with silos of Wi-Fi services. We have witnessed the jamming of the network during the day at some institutions due to heavy traffic. Students are to rely on their mobile-based Internet or

wait until after midnight for improved services. The wireless service across all the universities is poor, and it is only available in some parts of the university environment as shown in the responses below.

> *"Wireless is available but in a few places. For example, in this college of education, it is in a few very places, you must go to the administration offices or the Library to access the wireless" (male, 24, UDOM, 17/05/2017).*

> *"The university Wi-Fi has those concentration areas where you can have a good connection. For example, when I need to use Wi-Fi I go to [room] A110 where there is the Internet. So, I go and use it until I complete [my works] then I leave. The infrastructure is not that good. We depend on the university network to accomplish our work but slow and not always accessible. They should improve the Internet to make it faster (Female,22, MU, 12/04/2017".*

Third, policy readiness is crucial for the survival of micro-credentials. Both institutional and national policies should identify and value the system. Unfortunately, digital badges are not valued by the majority of employers and policymakers. Thus, the majority of badge owners find it hard to be either recruited or admitted into education systems. The existence of policies enforces the responsible units to recognise micro-credentials hence inspiring learners and educators. Also, the existence of policies that recognise micro-credentials will inspire institutions to venture into the project by either integrating digital badges into the designs of the courses or inspiring learners to participate in learning activities and earn digital badges from reputable issuers. Our study reveals that universities own various policies and strategies tailored to learning technologies. They include general ICT as well as e-learning policies that facilitate technology-mediated learning. However, they lack enforcement as well as content related to micro-credentials. In fact, the focus of the majority of institutions of higher education is on traditional teaching methods with the exception of few e-learning services.

4.4.3 Attitude towards Micro-credentials

The attitude of the stakeholders plays a significant role in the uptake of micro-credentials. To succeed, any move toward the issue of digital badges will need the support of educators, students as well as educational technologists. The behaviour of an individual is shaped by the belief associated with the concept. It is likely that if stakeholders believe that micro-

credentials are useful and have a positive outcome they will likely participate in the deployment process and use them. Although awareness of micro-credentials is low, upon introducing the topic to the respondents, it was revealed that the majority of the educators and students have positive attitudes towards the topic and are willing to participate in the project. The possibility of inspiring attention to skills-based outcomes in learning as well as the ability to recognise skills acquired through self-motivated learning appear to be attractive to the respondents. The responses suggest that the introduction of such a mindset into academic institutions would free educators from being solely responsible for the output generation. Learners will be responsible for their career and professional development. Similarly, the respondents were accepting of the possibility that the institutional mandate will expand thus improving the image as well as revenue of the institution. Hence, their attitudes suggest the existence of mental readiness from key stakeholders of education in higher education institutions.

4.5 Examining Policies and Strategic Documents

In order to make an informed judgement and to recommend presented results of micro-learning as well as micro-credentials, the scholar of this dissertation decided to examine important university documents especially policies in relation to learning technologies. The need for policy directives towards learning technologies is overemphasized (Isaacs & UNESCO, 2012; Jaffer et al., 2007). Policies set visions, missions and strategies that if well implemented, they lead to attaining organizational goals. Tanzania like many African countries has national ICT policies. These policies firmly stress on applying various ICT systems to enhance educational systems at all level. For example, the current ICT policy in Tanzania focuses on reducing the digital divide through the use of mobiles (Ministry of Works, Transport and Communication, 2016).

Hence, we conducted a literature search on the availability of policies related to technology-enhanced learning in the HEI in Tanzania. The websites of all the universities in the country, listed by the TCU are the source of information (TCU, 2018a). A total of seven policies were downloaded and analysed to discover commitments of the universities towards the following areas: integration of ICTs and micro-services in core university activities including teaching and learning, efforts to build capacity in ICTs skills and knowledge, establishment of an enabling ICT infrastructure and leadership towards the establishment of digital culture within institutions.

Our analysis has discovered that few of the universities have published a link of the ICT policies on the front page of their websites. Also, very few universities own separate policies specific for learning technologies. For example, Mzumbe University owns dedicated "e-learning and distance learning" policy while the UDSM is working in the same direction. These policies contain university commitments towards establishing an enabling environment for distance learning to occur. Also, the policy specifies the role of each individual-group involved in the process of e-learning delivery and learning. Other policies related to library, institutional repositories and research activities exist within the HEIs in Tanzania. The following are the key themes within the existing policies:-

4.5.1 Integration of ICTs in core University Activities including Teaching and Learning

The role of ICT systems in education is highly recognised within the explored policies. In fact, it is the overall theme, depicted in all of the policies. It describes the need to ensure that universities are able to leverage from the emerging ICT systems and tools to perform its core activities including teaching, learning and research. Currently, universities own different ICT systems and facilities that are not necessarily utilised as planned (Mtebe et al., 2011). Also, despite heavy investments in ICT solutions, universities are heavily relying on traditional systems (Ghasia, De Smet, et al., 2018a). Hence, these policies together with strategies provide visions that ensure investments in ICTs are highly aligned and offer means to realise the overall organisational goals. For example, UDOM "*commits itself to provide a resilient, secured and stable fast data communications network and services to support the various needs of the teaching, learning, administration and research domains*"(UDOM, 2018). Likewise, MUHAS declares that it "*shall give the highest priority to ICT, and enforce its application cohesively in all its core functions*" https://www.muhas.ac.tz/downloads/muhas-ict-security (16/10/2019).

4.5.2 Efforts to Build Capacity in ICT Skills and Knowledge

The existence of qualified human capital equipped with relevant ICT literacy and skills is vital in order to benefit from any ICT investment (Tedre, Ngumbuke, & Kemppainen, 2010). Because of the constant changing ICT ecosystems, organisations need to establish mechanisms to attract, recruit, upgrade and retain skilled employees. Within the explored policies, several commitments related to building capacity to both students and staff are made. They include commitment to prioritise skills development for ICT experts as well as

conducting trainings to other staffs and students. It is declared in one of the universities policy that "*The University shall plan and implement capacity building for ICT skills to achieve coherency and efficient utilization of its resources, and technical capacities of its staff as the need arises*" (UDOM, 2018). In order to ensure relevant skills are imparted, one of the strategies recommended within MU policy and others to conduct training needs assessment in order to identify skill gaps.

Other strategies are to recruiting and retaining qualified individuals. It is proposed that ICT literacy should be prioritized in all of the university recruitment processes. Also, commitments to establish strategies that would ensure ICT experts remain in their positions are outlined. Specifically, it is revealed in the SUA policy that the university will "*Ensure recruitment, development and retention of adequate ICT personnel*". Also, in order to cope with the ever-changing technologies, strategies to promote lifelong learning will be established as identified in the UDSM policy "*The College shall encourage activities relating to life-long learning processes both formal and informal for its staff*" https://tzfacts.com/university-dar-es-salaam-ict-policy/ (16/10/2019).

4.5.3 Establishment of Enabling ICT Infrastructure

ICT infrastructure is the backbone of all transactions performed against any ICT-based services including learning-related services. They include local area networks (LANs) that connect buildings and offices through wired and wireless channels. Also, it is the gateway to the Internet and its associated databases and services. Unfortunately, to establish and maintain such infrastructure requires a significant amount of budget and efforts. From the previous experiences, the majority of infrastructures in the majority of HEIs are financed by foreign aids (Ishengoma, 2016; Mtebe & Raphael, 2017; Nagunwa & Lwoga, 2012). Therefore, it is encouraging to learn that universities are committed to ensuring there is budget and skills to maintain the existing infrastructure without ignoring the need for expansion to meet the growing number of users. In particular, SUA declares that it shall *"develop, acquire and maintain quality infrastructure including LAN, PCs and the Internet to respond to the growing demands from students and staffs*" https://www.sua.ac.tz/phocadownload/ictpolicy2015.pdf (16/10/2016). Similar commitment is made in all other policies including from UDSM, "*The College shall ensure that a reliable and scalable state of the art ICT infrastructure, of adequate capacity, high-speed, cost-effective and of adequate coverage is maintained"* https://tzfacts.com/university-dar-es-salaam-ict-policy/ (16/10/2019).

In order to ensure sustainability, universities are committed to providing the necessary resources and management of infrastructure. They include ensuring the right number and type of facilities are procured and managed by responsible organs. Also, policies include commitments to protect infrastructure and users of the systems from any form of misuse. Evidently, in the UDOM policy, it is specifically expressed that "*The University strives to ensure the protection, resiliency and stability of all University ICT infrastructure, the information held therewithin and services against any cyber threats*" (UDOM, 2018). Similarly, the UDSM commits itself that *"shall put in place measures to ensure confidentiality, integrity and availability of its ICT resources*". Still, in order to satisfy the communities, the majority of these policies acknowledge and identify the importance of foreign assistance in establishing relevant infrastructure. For example, MUHAS policy commits to working with foreign partners to creating and managing infrastructure in the statements including this "*The University shall utilize the existing partnerships and seek new partners to regularly improve MUHAS ICT infrastructure and services*". In fact, if these policies and strategies are to be implemented, both students and staffs will be assured of reliable access to quality ICT services.

4.5.4 Leadership towards the Establishment of Digital Culture

In order to establish and maintain digital culture within institutions, several policy statements and strategies are outlined. They range from imparting digital literacy to students and staffs, to promoting the use of various digital platforms available within institutions. In particular, it is declared within MUHAS and KIUT policy that "*the University shall promote ICT Research, Development and Innovation culture and practices for various units and programmes"* https://www.muhas.ac.tz/downloads/muhas-ict-security & https://kiut.ac.tz/downloads/ (16/10/2019).

. Likewise, UDSM goes beyond the university boundaries to include partners in the establishment of digital culture to improve productivity in one of its policy statement "*The College shall work with the private sector, civil society and other partners in promoting, stimulating and encouraging the use of ICT for increased productivity*". Other strategies include establishing platforms to "*Promote the use of e-teaching and e-learning"* and lifelong learning for the people to constantly improves their awareness and skills.

Because we have identified the existence of policies within fractions of institutions of higher education, one would like to know if the existence of these policies is positively transforming

the higher education institutions in Tanzania. The general challenges we have deducted from the literature concerning policies is the lack of implementation and enforcement (Ghasia, Machumu, & DeSmet, 2018b). Also, contradictions exist between what is spelt within policies and the actual situations in the institutions. Specifically, we have observed very ill situations related to infrastructure and digital culture in all of the visited universities as we critically present them in chapter 5.

4.6 Lessons Learned

Upon successful analysis of the situation concerning micro-learning and micro-credentials in the HEIs in Tanzania, the following are the important lessons to explore further:

4.6.1 The Existence of Conflicting Reactions between Students and Educators

The results presented concerning micro-learning and micro-credentials reveal that students and educators are divided about the awareness, experience as well as reaction concerning if micro-learning is a deserving pedagogical approach. In fact, students' reactions are far ahead of their educators in every aspect. Likewise, the situation is almost identical to micro-credentials. We believe that these differences need to be explored further to understand the causes. Significantly, it is important to understand the meaning of the divided opinions in order to devise policies that will ensure sustainable deployment of services. The question that puzzles the researcher is whether the division suggests a shift of focus from the traditional educational approach to the more modern appealing approach by the students. Does this suggest that students and educators are inclined towards two different teaching and learning methods? If so should the institution follow educators or students? Or maybe this situation suggests the battle between digital immigrants and natives as explored by Zur & Walker, (2011). The relevancy cycle of the design science suggests responding to the needs of the students. Hence, the situation suggests the need to focus on the bottom-up approach rather than top-down.

4.6.2 The Existence of Readiness Issues in HEIs is real

As the results suggest, there are a number of institutional as well as individual readiness issues related to micro-learning and micro-credentials implementation. While, the detailed discussions concerning the challenges are provided in chapter 5, here we reveal that much need to be done for the two approaches to be accepted, recognized and deployed. Specifically, the HEIs need to focus on the establishment of digital literacy as well as digital

and learning culture to enable educators to live up with innovations as well as to cope with the ever-changing technological ecosystem.

4.6.3 The Existence of Positive Attitudes towards Micro-learning and Micro-credentials

Likewise, the results presented in the previous sections provide a snapshot of the reactions about the two concepts. My experience as the researcher in the fields, during discussions and interviews, is far wider than neither charts nor extracts can reveal. Especially, students are enthusiastic concerning the recognition of skills acquired from self-directed learning. The coming of digital badges in either open-badge or private form is likely to improve the situation.

4.6.4 The Need for Practical Interventions

The item 4.1.2.4 of this section chapter highlights the need to address readiness issues related to micro-credentials and micro-learning. The results, as well as our experience in the field, reveal the lack of experiences in the area of micro-learning and micro-credentials. Also, as results suggest, the HEIs are ill-prepared to embrace the two concepts. Also, the existing policies are blind when it comes to the aforementioned approaches. Hence, the best way to build confidence and experience is through a practical solution. In this aspect, the author promotes the introduction of Ujuzi App and similar applications in the universities so as spread practical message concerning the efficacy of the approaches.

4.6.5 The Need for Leadership towards Transformations

Our research focused on HEIs in Tanzania. We argue that the extended version of this study should focus on the upper levels of the academic system in the country, the ministerial levels. Experience suggests that decisions made at the upper level are naturally implemented by the institutions. Also, the results suggest that the problem in the institutions is not the existence of policies but the implementation of the existing policies. In chapter 7, we provide a model as well as recommendations concerning deployments.

4.7 Chapter Conclusion

In this chapter, we presented Tanzania HEI's account concerning micro-learning and micro-credentials approaches. Specifically, as the results suggest, micro-learning and micro-credential researches are at the infancy stage in Tanzania too. To date, HEIs in Tanzania are yet to formally deploy either of the two approaches. Also, none has established research in

the area of micro-learning. This might be the result of missing policy directives as well as awareness and experience in the subject. Reflecting on the state of liminality facing the HEIs in Tanzania, government intervention in terms of support is needed. The support should range from establishing policies that identify and recognize micro-learning services and skills achieved through it to create an enabling infrastructure suitable for technology-mediated learning. These interventions are justified by the positive reactions and attitudes of the stakeholders towards micro-learning and micro-credentials which is consistent with the literature across the globe (Polasek & Javorcik, 2019; Steinbacher & Hoffmann, 2015). As it is revealed, both students and educators are banking on micro-learning to inspire focused, timely, skills-based and lifelong learning. Importantly, we have demonstrated that although the universities lack key skills on micro-learning, they have necessary experience in dealing with technology-mediated learning.

Because this is the first work of its kind in the area of micro-learning in Tanzania, there are a number of issues that the researcher was not able to explore. Likewise, there are a number of limitations that scholar was unable to mitigate. For example, this work relied on the account of the people who have little experience concerning micro-learning usage and deployment. Also, the work was carried out in just four universities something that challenge the ability to generalize the findings. Therefore, other scholars should expand the scope of this work to include all other universities in Tanzania, Africa and beyond. Moreover, there should be research tailored towards the impact, relevancy and application of micro-learning in various sectors of lives. It is our belief that the knowledge acquired from this work will inspire more works of the same kind in order to improve knowledge, possibilities and opportunities associated with micro-learning services, concepts as well as technologies.

CHAPTER FIVE

CHALLENGES FOR MICRO-LEARNING DEPLOYMENT IN HIGHER EDUCATION INSTITUTIONS OF TANZANIA

5.1 Introduction

This chapter provides a critical analysis concerning objective number two of this study: to explore challenges that hinder micro-learning deployment in the HEIs especially in Tanzania. It builds on chapter 4's theoretical and conceptual discussions on micro-learning and chapter four's discussions concerning the status of micro-learning deployment in the Tanzanian HEIs. These discussions expand understanding of the micro-learning agenda and its associated concepts.

Because studies on micro-learning are still emerging, also since deployment of micro-learning is contextual in nature, it is pivotal for scholars from various settings to share knowledge and experience. This chapter is influenced by the experience acquired during the qualitative and quantitative inquiries on issues that are detrimental to the success of micro-learning deployments in the HEIs, with Tanzania as the case. In order to ensure the rigour of this work, the findings from the study are compared to seminal works.

The chapter is organized as follows: it starts with the introductory remarks in *section 5.1* in which the content of this chapter is positioned together with the rest of the document. Then we provide detailed discussions concerning micro-learning implementation in *section 5.2*. In this section, a detailed account of the lessons learned from the preceding chapters is shared. Next, the main discussions concerning the challenges are presented in section *5.3.* In this section, the description of the methods used to realize the results, as well as discussions of the challenges, are outlined. In the end, the chapter conclusion is provided in section 5.4 in which the summary of the chapter as well as an indication of the future work are communicated.

5.2 Background Information

Ever since its inception, over a decade ago, micro-learning has attracted a handful of researchers from across the globe (Hug, 2005). Various scholars have written about its efficacy and effects especially with regards to the millennium learners (Bruck et al., 2012; Giurgiu, 2017). Unfortunately, unlike mobile learning, micro-learning inception and deployment has scarcely been the subject of reports, in Africa and Tanzania in particular. It is the lack of literature concerning micro-learning deployment that prompted our work in the

four HEIs in Tanzania. Especially, we explored micro-learning potentials in Tanzania by integrating stakeholders' reactions and attitudes in our observations of the actual situations in the universities. In particular, stakeholders believe that a successful micro-learning implementation of micro-learning services will inspire skills development as well as lifelong learning (Hug, 2005; Zhao, Xia, & Zhu, 2010).

Based on the situation analysis conducted in the four universities in Tanzania, and the Ujuzi app implementation at Mzumbe University (chapter 6), it is apparent that students and experts are ready to participate in the micro-learning project by devoting their resources and efforts. Likewise, it is clear that due to the unfamiliarity with micro-learning, institutions in Tanzania are ill-prepared to cope with changes in learning styles. Specifically, micro-learning requires changes in the curricular among both educators and students (Polasek & Javorcik, 2019).

Likewise, the experiences acquired during the implementation of other technology-mediated learning such as e-learning, m-learning as well as blended learning suggest that the transformation journey that started over a decade ago by the HEIs is yet to reach its intended destination (Mtebe & Raphael, 2017; Tedre et al., 2010). We can argue that the learning institutions in Tanzania are still in the situation that was once described by Uimonen (2012) as a *liminal state, neither here nor there* in her scholarly work "Digital Drama: Teaching and Learning Art and Media in Tanzania". Unfortunately, scholars are yet to devise measures to rescue the HEIs from current circumstances.

Significantly, micro-learning as the new teaching and learning approach brings about its set of complications to the HEIs. First, to date, there are neither established theories nor models for the micro-learning deployments in the academic settings. Also, as it is described in the fifth chapter of this document, among problems that are yet to be addressed by the experts as well as researchers in the management of and access to micro-learning units from various issuers: the structure of micro-learning course can obstruct or facilitate (Kadhem, 2017). If we take the Polasek & Javorcik (2019)'s case as an example, to convert a normal course of ten topics to a micro-learning course resulted in 120 micro-learning units (MLU). Hence, the 120 MLU structure course requires additional effort to manage and access them if not well organized. Therefore, it is worthwhile to explore and communicate knowledge related to micro-learning deployment including challenges in various contexts as presented in this chapter.

5.3 Micro-learning Deployment Challenges

Just like any other technologies, micro-learning deployment is contextual and felt differently by the people of different communities. Also, because the micro-learning idea is linked to the use of mobile technologies, there is no doubt that it inherits some characteristics of m-learning as we described in chapter 2. Specifically, learning through micro-learning would not be possible in communities where individuals lack the ability to own and pay for mobiles and Internet subscriptions. Similarly, it is unthinkable to expect micro-learning to flourish in environments where either there is low ICT literacy or mobiles are discouraged in the school settings (O'Hagan, 2013). Therefore, it was necessary to involve those affected by micro-learning deployments in co-designing and co-creating the meaning of such deployments including challenges. The challenges reported in this chapter are identified in collaboration with the academic stakeholders from the identified universities in Tanzania.

5.3.1 Instruments and Participants

As described in the methodology chapter, the methods we used are combined. They include a survey that involved 172 students, 41 lecturers and 19 education technologists from the four universities in Tanzania. On top of that, strategic documents such as policies and student bylaws and websites were studied to identify relevant information related to the study. In addition, in-depth interviews were carried out to 53 students, 30 lecturers, 9 technologists and 8 members of the management team who are in charge of deployment and overseeing the deployments of technology-enhanced learning. The whole of the survey and interview guides are attached at the back of this dissertation (annexes 4.1 &4.2). The scale concerning the micro-learning challenges contained eleven items. Of the eleven items, seven are common to all of the three groups of respondents (students, education technologists, and lecturers), one is specific for students and technologists whereas three are unique to technologists as shown in table 5-1 with their associated cumulative percentages and further discussed in section 5.3.3.

		Cummulative %		
Challenge	**Item of the Scale**	**Technologists**	**Students**	**Lecturers**
Skills shortage	Existence of enough number of skilled manpower	47		
	lack of digital illiteracy amongst players	32		
	Availability of the competent instructional designers & developers of micro-contents	53	77	43
Resistance to change	Low adoption rate from the academic staff	53		
lack of local micro-learning services	Locating micro-content(s) offered by the Tanzanian institutions	21	59	48
	Identifying authentic issuers (providers) of the micro-learning services	47	63	38
Accessibility issues	Paying for the sold Micro-learning contents/services		77	43
	Availability of relevant infrastructure to support micro-learning	63	69	43
Unsuportive political environment	Existence of necessary institutional policies tailored towards micro-learning	42	77	38
	Existence of necessary national policies tailored towards micro-learning	42	73	48
	Keeping with the changing pace of the micro-learning content worldwide		75	38
	Overal Score	**37**	**67**	**38**

Table 5-1: Micro-learning challenges in Tanzanian HEIs

5.3.2 Data Reliability

Because we used the Likert scale to investigate the opinions of the respondents towards deployment challenges, it was necessary to conduct a reliability analysis of internal consistency of the scale before they could be translated into actual research findings (Gliem & Gliem, 2003). Just like in the previous chapters, we applied the Coefficient Alpha to analyze the reliability of the internal consistency of the scale related to micro-learning challenges for each category of respondents. The test was carried out successfully, without any modifications or standardization of the items. The outcomes of the reliability analysis indicate a high degree of internal consistency: technologists (.905), students (.909) and lecturers (.942).

5.3.3 Discussions of the Results

Table 5-1 above provides the results from the survey of students, technologists, and lecturers. The results are combined with the results of the interviews to form the bases for the discussions concerning challenges that hinder micro-learning deployment in the HEIs in Tanzania. Principally, all categories of stakeholders stress the need to improve situations at the universities so as to allow smooth offering of micro-learning services. The following are the main challenges that, if not addressed, will continue to affect micro-learning service delivery in a negative way.

5.3.3.1 Limited Access to Micro-learning Services

Access to micro-learning is essential for learning to occur. Especially, in a connected world, learning is a network-forming process (Siemens, 2014). Learners traverse the learning nodes (human and non-human), spread across the globe to locate relevant learning contents (Bell, 2011; Dunaway, 2011). In Tanzania, we have learned the existence of various challenges that limit access to micro-learning services including the following:-

First, access to micro-learning is hampered by the nature of micro-learning itself. Micro-learning sessions are made of a large number of micro-units which are hard to organize and access (Polasek & Javorcik, 2019). In chapter 6, we demonstrate how useful brokerage services are in order to solve this kind of problems. Due to the lack of such services, learners are forced to immerse themselves in global spaces to search for micro-learning units that fit their needs. Unfortunately, for unskilled learners, this process is time-consuming and associated with the risk of accessing low quality as well as unreliable contents. In Tanzania, a majority of learners are ICT illiterate, except at the higher education level. Thus, they are the victims of the situation.

Secondly, another factor is the inability to own mobiles as well as paying for the Internet subscription as well as sold micro-learning services. While some studies indicate that the majority of students and teachers own mobiles (Chambo et al., 2013; Mtebe & Kandoro, 2016), the reality is that a good number of Tanzanian students neither own mobiles nor are capable of paying for the Internet (Baelden et al., 2014; Ghasia, De Smet, et al., 2018a). In fact, the majority of students depend on insufficient loan from the government to buy mobiles (Ghasia, De Smet, et al., 2018a). Because the loan is not sufficient, students sacrifice their meals and stationeries to enable them to buy their mobiles. The situation is even worse for students who are not given a loan by the government as described by one of the students:

> "*Now there is another person who has no boom [loan] and at home, low income, so cannot [afford to] own. At home, they are only able to give him/her meal allowance" (female, UDOM, 30, 11/3/2017).*

Hence, those not lucky to receive the loon are incapable of owning smartphones or paying for the Internet thus not able to participate in mobile learning. Hence the emergence of the new sociality of sharing a hotspot, a friend with enough data shows solidarity with the have-not. The Connectivist ideal lurks again at the horizon through people's resilience, scantily

rewarded. Needless to repeat that the bricolage reproduces the hierarchy of modes, which is an Internet society means: the duped are aware.

Likewise, in a survey, 78% of the students identified the ability to pay for micro-learning services as a challenge whereas only 3% of the student did not see it as a challenge. The 20% of remaining students were neutral on the subject as indicated in figure 5-1 below.

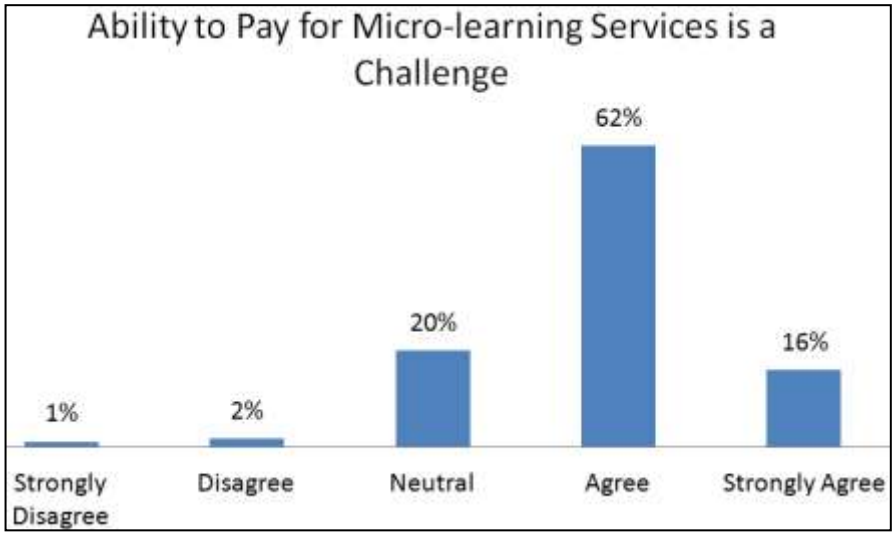

Figure 5-1: Students reactions to the ability to pay for micro-learning services

Thirdly, access to micro-learning services is restricted by the lack of quality Internet services at the universities. Particularly, Wi-Fi services are accessible in silos, very few locations especially administration offices and selected few classrooms:

> "*There is Wi-Fi [services] but in very few places. For example in this college there are few areas, sometimes you are forced to go to the main administration or library" (male, UDOM, 25, 12/3/2017).*

Moreover, universities are subscribed to very low bandwidth services due to financial difficulties. The maximum bandwidth capacity for the majority of the universities is 80mbps download and upload. No wonder, the university networks are commonly overloaded during working hours (Ghasia, De Smet, et al., 2018a). In fact, the survey results indicate that 69% of the student are dissatisfied by the state of the infrastructure, 21% are neutral on the subject, whereas only 10% seem to be satisfied as indicated in the figure 5-2. Consequently, it is impossible for learners to control their learning experiences to happen anywhere, anytime and at any-pace as required by the Connectivism learning theory of the digital age.

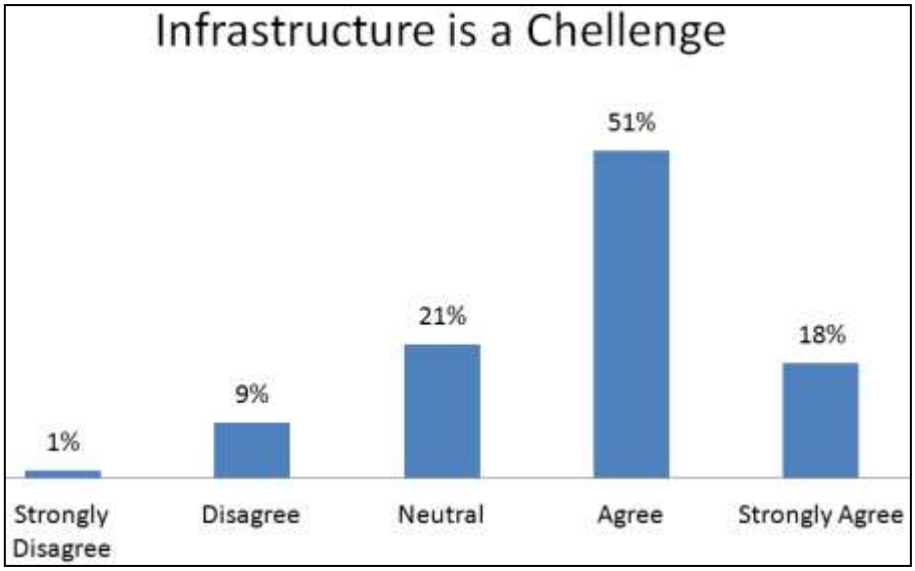

Figure 5-2: Students reaction to the state of the Infrastructure

5.3.3.2 Shortage of Relevant Skills within the HEIs

Similarly, micro-learning success depends on the availability of skilled learners and educators. On the one hand, educators are responsible for designing and creating course curricula, contents as well as learning activities (Anido et al., 2002). On the other hand, in order to be able to browse the Internet and consume course contents, learners need to possess adequate competencies especially digital and analytical skills to allow them to synthesize contents from various issuers (Dunaway, 2011; Siemens, 2014). Therefore, it is vital for the institutions to have an adequate number of qualified employees in all key competencies desired for successful micro-learning deployments. Such skills include instructional design, multimedia processing, quality control as well as curriculum design.

Unfortunately, the situations in the universities are not favourable. Particularly, the majority of students and educators lack adequate digital skills because, despite the fact that ICT education is emphasized in the national ICT policy, it is not adequately prioritized and offered in all pre-university levels (Tedre et al., 2010). Subsequently, only a few students, children of the middle and high-income families, who manages to learn in private schools, have access to these skills. The majority of the students rely on the HEIs to offer ICT education upon joining the universities as witnessed by one of the students:

> *"Universities are supposed to train. There are some who come here [they] have no basic skills, even computer basics" (female, OUT, 27, 10/12/2016).*

Subsequently, all universities have resorted to designating a specific subject to impart basics of ICTs to students, as it has already been done at MUHAS (Nagunwa & Lwoga, 2012).

Likewise, we have witnessed the lack of skills relevant to online course design, administration, and offerings in the universities (Mtebe & Raphael, 2017; Nagunwa & Lwoga, 2012; Tedre et al., 2010). As it is described in chapter four, the awareness of micro-learning is low. In all of the visited universities, there is no employee with adequate skills relevant to micro-learning course design and services. Also, only UDSM and UDOM in Tanzania have dedicated units responsible for content development for the online courses (Ghasia, De Smet, Machumu, & Musabila, 2018a; Mtebe & Raphael, 2017). However, those units lack manpower and equipment (Tedre et al., 2010). The situation is well articulated by one of the technologists in one of the universities:

> "*Manpower is very low, we face many challenges when we want to tell them how to support ICT staff. We have tried to introduce that every college should have two ICT staff but we have failed. For example, this college has over 7000 students and 200 staff. All of them depend on one or two ICT staff for support" (male, UDOM, 32, 12/10/2018)*.

Likewise, the survey to students reflect on the above claim from the technologist as 77% of the students view the lack of key competencies in their institutions as a challenge to micro-learning deployment whereas 15% are neutral on the subject, and the remaining fraction do not consider it as a challenge (see figure 5-3).

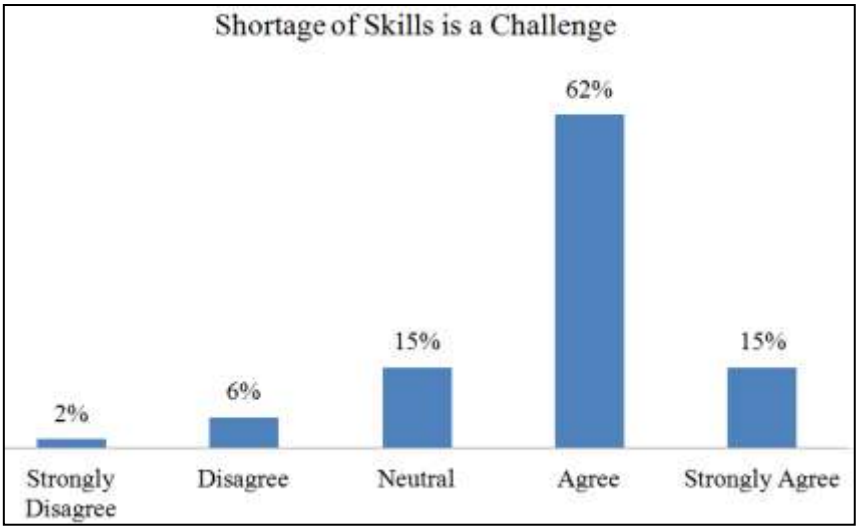

Figure 5-3: Students reaction to skills shortage

Therefore, unless serious investments are done in the HEIs, the initiatives to embrace technology-mediated learning of various forms will likely fail to deliver the desired results.

5.3.3.3 Resistance to Change

It is important that once the systems are deployed they are used. Especially, due to the relative advantages brought by these technologies, both students and educators are expected to leverage from these deployments. For example, micro-learning systems provide lecturers with necessary tools to author learning contents, monitor and manage learners progress as well as to assess and collaborate with learners from anywhere and anytime (Giurgiu, 2017; TalentCards, 2019). In particular, the usefulness, simplicity, and flexibility of applying micro-learning tools to improve both teaching and learning experiences to lecturers and learners respectively. In addition, micro-learning platforms offer the possibility to expand the reach of universities to offer services to communities outside university boundaries (Aigerim & Azamat, 2014; Buchem & Hamelmann, 2010).

In the interviews with educational technologists, it was revealed that the majority of the academic staff have the tendency of resisting new teaching and learning technologies (Mtebe & Raphael, 2017). Likewise, the survey result indicates that fifty-three per-cent of the technologists believe that micro-learning deployment suffers from resistance from stakeholders especially the academic staff. Contrary to the resistance from lecturers, students have always shown interest to test and use new methods (Polasek & Javorcik, 2019; Steinbacher & Hoffmann, 2015). For example, the e-learning utilization trends at the MU reveal that students have a high access rate to online courses.

Unfortunately, resistance to change is not something new, it is associated with human nature (Waddell & Sohal, 1998). People will likely resist any changes that disturb the equilibrium of ways they are accustomed to (Tedre et al., 2010). During the interviews, some lecturers expressed their frustration regarding the way deployments are conducted at their institutions. Specifically, they claim not to have been involved in the selection and deployment of the technologies. Likewise, they are not supported by the institutions with necessary training and resources as expressed by one of the lecturers:

> *"Why should the lecturer use his [resources] computers, mobiles and pay for the internet to perform university duties?" (Male, MU, 46, 10/3/2018).*

Nevertheless, the lecturer's claims concerning their involvement during selection and deployment projects are strongly refuted by the technologists and members of management teams who argue that trainings are continuously offered to lecturers.

5.3.3.4 Lack of Locally Made Micro-learning Services

The success of micro-learning and micro-credential deployments rely on the availability of providers of the content. Issuers of micro-learning and micro-credentials are individuals, organizations, companies, association or institutions with needed experience and capacity to deliver services (Ghasia, Machumu, et al., 2018b; Priest, 2016). In order to be assured of the availability of micro-learning services for the Ujuzi app, we explored the HEIs in Tanzania to determine the availability of local issuers. Similarly in the survey, we asked respondents to reflect on the availability of local issuers of micro-learning services.

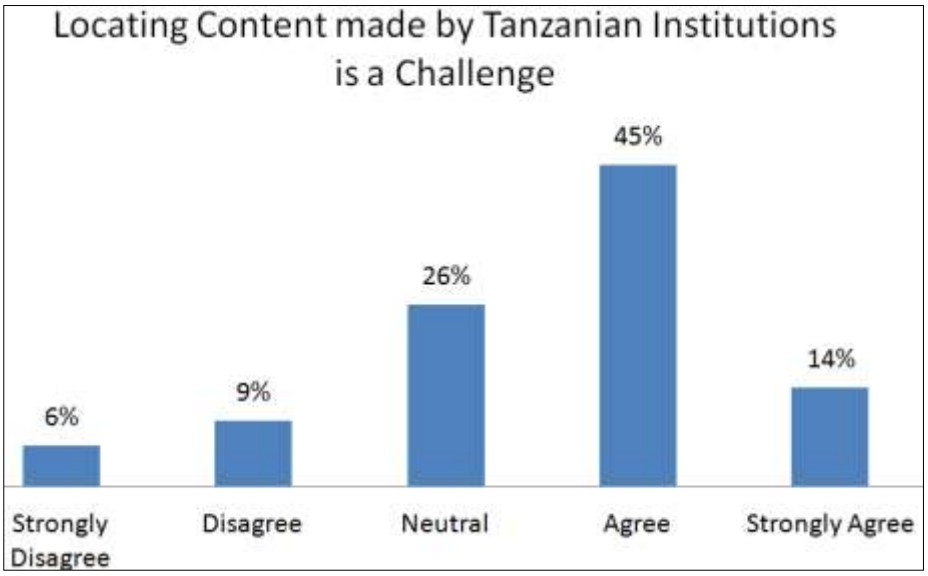

Figure 5-4: Students' reactions concerning content

Results indicate that in Tanzania there is a lack of qualified issuers of micro-learning services. The figure 5-4 above reveals that almost 60% of the students agree that it is a challenge to locate contents produced by the local institutions, whereas only 6% and 9% of the student respondents strongly disagree and disagree respectively. The remaining 26% are neutral on the subject. Apart from the Vsomo app that is issued in a collaboration between Airtel, a mobile communication provider, and the Vocational Education Training Authority (VETA), there is no other micro-learning services known to be issued in Tanzania ("VETA," 2019). However, a number of educators from the visited institutions have indicated their interest to participate in the issuance of free and sold micro-learning content. This suggests the need for national and institutional-wide initiatives directed to micro-learning services for skills delivery as well as knowledge production. Also, the availability of many local providers of micro-learning services will enhance and impart skills and knowledge concerning innovations in Africa across the globe.

5.3.3.5 Overreliance on Traditional Systems

Overreliance on the face-to-face approach is the biggest challenge in the learning institutions (Mtebe et al., 2011). The digital drama case at Tasuba and the e-learning deployment at UDSM presents snapshots of how transforming the education institutions in Tanzania is an uphill task (Uimonen, 2012). Despite some efforts to digitize some activities such as admission and student record keeping, to a large extent, the predominant model of academic delivery remains to be face-to-face (Ghasia, De Smet, et al., 2018a). Also, both curricula and strategic documents including the examinations-bylaws- consisting of rules, procedures and guidance on examination matters, from the visited universities reflect on the traditional systems. To some extent, introducing as well as applying digital approaches intrudes upon the well-established standard procedures. For example, the majority of examination-bylaws in the universities necessitate students to physically attend classes for at least a ratio of between sixty and eighty percent of lecturing time for them to be eligible to undertake final examinations. The following is an extract from MU's examination bylaw:

> *"The overall attendance of the candidate in every subject must not be less than 60% of the contact time allocated to the subject in the respective semester. Failure to meet this requirement the candidate shall be treated to have absconded from studies and will be de-registered."* *https://site.mzumbe.ac.tz/images (21/10/2019)*

Also, both students and lecturers are accustomed to traditional face-to-face systems that make it hard to shift their focus to learning and teaching in isolation. For example, at MU, students expect their lecturers to give them printed lecture-slides at the end of each session (Baelden et al., 2014).

5.3.3.6 Unsupportive Political Environments

For micro-learning to flourish in HEIs in Tanzania, they should be recognized and used. Specifically, learners need to feel recognized and recruited based on their micro-learning skills and qualifications. This requires the availability of a suitable political environment shaped by policies and procedures that recognize and accredit micro-learning courses as well as services. Relevant bodies such as the TCU or the National Council for Technical

Education (NACTE) in Tanzania are supposed to establish quality standards to be used to establish and accredit micro-learning courses. Similarly, it is essential for institutions to formulate their own policies and guidelines that translate and implement national policies. Specifically, policies are required to provide vision and commitments to implement and use technologies or innovations.

While we reported on the presence of institutional and national policies regarding technology-mediated learning in the HEIs in Tanzania, micro-learning is not reflected in any of the identified policies. In fact, these policies are tailored towards e-learning and not micro-learning. In addition, these policies and strategies are not enforced (Ghasia, De Smet, Machumu, & Musabila, 2018a). On top of that, mobiles are not formally recognized by the policies as the desirable media for academic delivery (Isaacs & UNESCO, 2012). Consequently, instead of leveraging from these high proliferating devices, lecturers and schools prohibit students from using these technologies in schools and in classrooms (O'Hagan, 2013). The recent incident in Tanzania, the Regional Commissioner for Mbeya Regions is seen publicly whipping the high-school (grade 13 and 14) students of the Kiwanja Secondary School for having mobile phones at school just highlights the root of the problem (EATV, 2018). No wonder, more than 77% of the students who responded to the survey believe that there is a lack of policy directives towards micro-learning at national and institutional levels (see figure 5-5). Evidently, micro-learning is not considered as a legitimate learning approach in all the universities' policies and strategies in Tanzania. In practice, some lecturers leverage from the silence of the policies to bring micro-learning contents from the Internet in their course delivery.

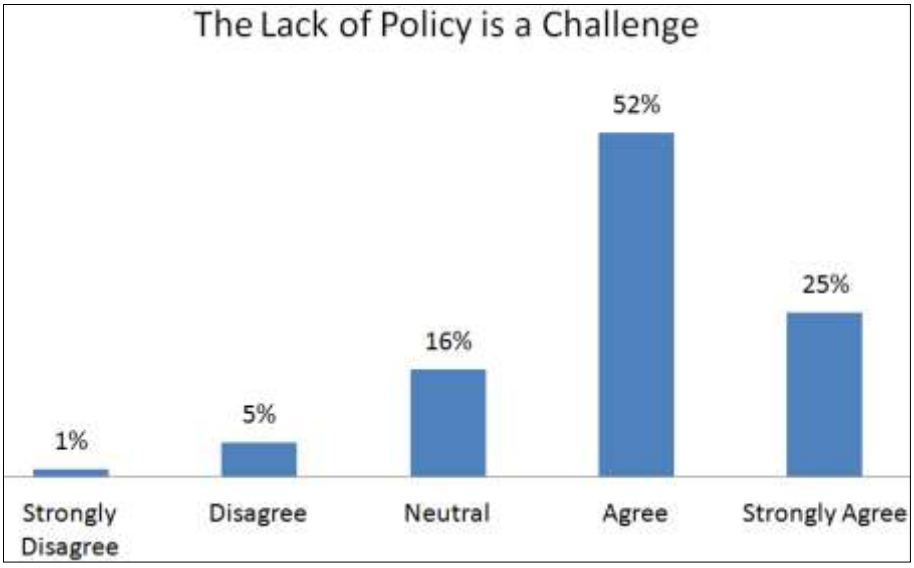

Figure 5-5: Students reactions concerning the availability of policy

5.4 Chapter Conclusion

This chapter is exclusively dedicated to micro-learning deployment challenges in HEIs in Tanzania. It is clearly described that, in order to fully leverage from micro-learning and mobile services, the identified challenges have to be addressed by the responsible organs and individuals. Specifically, some of the identified challenges such as the lack of digital literacy and competencies have deeper roots in the education systems in the country. In particular, ICT education is not offered to the majority of Tanzanian students throughout pre-university levels (Nagunwa & Lwoga, 2012; Tedre et al., 2010). Therefore, in order to address these challenges, respondents call for the provision of digital skills and knowledge starting from low education levels. Other challenges are associated with the governance of the institutions; to some extent, issues related to resistance are due to the lack of appropriate strategies to engage and support educators and students. Lecturers believe that if they are well involved in the decision-making processes and given training and necessary tools they will effectively participate in the transformation projects.

Principally, micro-learning research is yet to mature. More researches are needed in order to attune micro-learning and its associated services to the needs of society. In chapter 7, we propose a micro-learning deployment model for HEIs in Tanzania. The model is co-created in collaboration with academic stakeholders from the four universities. In the model, we stress on a coherent approach, to ensure all relevant stakeholders and experts are involved in the processes. For example, micro-learning deployment should result in policy adjustments to recognize and utilize micro-learning services and skills. We encourage more researches in the area of micro-learning service delivery in order to boost knowledge, understanding, and application of micro-learning services in all works of lives.

It is important to note that, some of the identified challenges are chronic in the HEIs. They have been identified and analyzed by prominent e-learning scholars in the country including Mtebe & Raphael (2017) and Nagunwa & Lwoga (2012, p. 201). However, these scholars did not provide solutions on how to address the challenges. Hence, we proposed the use of brokerage services in order to foster access to learning resources and interaction between learners and issuers of micro-learning services as discussed in the next chapter.

CHAPTER SIX

THE ROLE OF BROKERAGE SERVICES IN MICRO-LEARNING DEPLOYMENT: THE CASE OF THE UJUZI APP IMPLEMENTATION AT MZUMBE UNIVERSITY

6.1 Introduction

Chapter two of this document provides a detailed description of micro-learning deployment in various situations. Research suggests that despite the high popularity it receives, micro-learning architecture causes significant challenges concerning access and administration of micro-learning units (see item 2 in figure 2-1). In an attempt to address these challenges, the present chapter explores the role of brokerage services in micro-learning deployment, the third objective of this study. Specifically, we provide a critical account of how brokerage services offer possibilities to bring together learners and issuers of micro-learning services so as to enhance access to quality and authentic micro-learning units. Moreover, we demonstrate how one of the artefacts, the Ujuzi app is applied at Mzumbe University to broker micro-learning services to diploma and degree programs.

Because learning through micro-learning corresponds to a network forming process, with learners accessing and consuming knowledge and skills issued by issuers across the globe, the discussions in this chapter are informed by the Connectivism learning theory. Therefore, we explain how the Ujuzi app bridges the navigation gap that learners with low ICT skills face as compared to the experienced learners as well as issuers. We propose a new approach through the Ujuzi app to do broking of micro-learning as well as micro-credential services. After the positive evaluations obtained by the ICT experts, students and academic staffs, limitations of the app are discussed to broaden knowledge as well as open room for future work.

In order to simplify the process of digesting the content, the chapter is organized as follows: the chapter introduction precedes the background information concerning brokerage services and their roles in education and micro-learning in particular. In section 6.2, we describe the gap that the Ujuzi app is filling based on the literature. In section 6.3, we provide a detailed discussion concerning the Ujuzi implementation at Mzumbe University. In particular, we explore each of its features and the way it is used. In addition, the discussions about users' reaction towards Ujuzi designs and features are presented in the same section. Section 6.4 reflects on the process by sharing lessons learned. The chapter ends with the conclusive remarks in the chapter summary in section 6.5.

6.2 Background Information

In chapter two we have provided a detailed description of the micro-learning challenges that are yet to be addressed by the current approaches. Specifically, we have indicated that a micro-learning course is made up of a multitude of independent and focused micro-units that require significant effort to navigate and process (Bruck et al., 2012). Due to the high number of providers coupled with the democratic nature of the internet, we argue that learners are subjected to learning materials of various levels of quality. Across the globe, for example in Africa, where digital and Internet skills are limited (Chetty et al., 2018), there is no doubt that a significant number of unskilled learners will be excluded from leveraging the high profiling learning approach. The actual scenario of the learner in the micro-learning environment starts with using search engines to look for micro-learning units from the Internet. Next, the list of the URL links pointing to each micro-unit from providers is retrieved into their screens. Then, learners have to explore each of the links to decide on the most relevant and suitable to use. For unskilled learners, this process is frustrating and risky.

Also, the crowded Internet makes it harder for the providers of micro-learning content; the appearance of the products in the front pages of the retrieved data is a challenge. Besides, the visibility and prospect to be chosen by the learners is hampered by the ability to feature in the front of the lists. Therefore, we argue that the introduction of brokerage services in the middle between learners and providers of micro-learning will speed up the process of information discovery as well as improving visibility and quality of the content by filtering out inauthentic providers. The description of how brokerage services can be used to improve navigation and quality gaps in the micro-learning arena is provided in the next section. This work presents a critical account of the Ujuzi implementation at Mzumbe University in Tanzania to address micro-learning challenges described above.

6.3 The Ujuzi App Implementation at Mzumbe University

The Ujuzi App refers to a broker application that is developed to address issues related to micro-learning deployment. Just like other brokerage services, it mediates relationships between customers (referred to as learners) and providers (referred to as issuers) of micro-learning services. In particular, learning under micro-learning corresponds to the Connectivism learning theory in that it is a network forming process that learners rely on with the existing expertise distributed across the Internet nodes (Siemens, 2014). Learners with the ability to traverse nodes and synthesize contents are able to leverage from the public and democratic space. Due to the fact that the initial information extracted from the data collected

in the four universities revealed a low level of digital literacy among students and educators, it was essential to intervene with the situation by developing a technological solution. Particularly, participants revealed their frustrations concerning the lack of ICT trainings during their pre-university education. Furthermore, because the majority of the students own low capacity smartphones that can only process a small amount of instruction, micro-learning was the suitable choice. The following fragment was extracted from student interviews we conducted:

> *"Another thing I want to advise the Government [of Tanzania] is to initiate those [ICT] skills at advanced level secondary schools. There are trained teachers capable of helping students so that they should get to universities equipped. This is because the majority of Tanzanians are from low-income families, very few are capable of owning computers at home, and when they join universities they struggle a lot" (Female, 24, UDOM).*

One of the critical questions today concerns the neutrality of technology. We conform to the critical theory of technology that claims that within technologies there are social and political values embedded within designs and shaped by usage (Allen-Brown & Nichols, 2004; Feenberg, 2005). Through a co-design approach, designers and stakeholders worked together to identify and manifest the app to fit their needs as detailed in the methodology chapter. We can reveal that the design and deployment of the Ujuzi app to leverage from the high profiling mobile technologies in Africa is shaped by three agendas as discussed in the coming paragraphs:

The first objective is to inspire lifelong and skill-based learning through micro-learning. The ubiquitous nature of mobiles offers opportunities for learning to follow learners wherever they are, while commuting, on-site and off-site, during a break at the beach just to name few. Embedding micro-learning activities that suit learners positioning and lifestyle is likely to make learning habitual. Also, because micro-learning is proven to be focused and skills related, by improving time needed to retrieve micro-learning services through the use of the Ujuzi app will enable learners to actively engage in searching various knowledge and skills.

Second, to facilitate micro-learning deployment projects by adding new knowledge related to brokerage of micro-learning services it facilitates fast location and discovery of learning contents from various providers.

Third, to inspire production and sharing local knowledge to the society; the Ujuzi app offers a platform for African scholars and practitioners to share their proven skills and knowledge to

the wider community. In particular, Africa is claimed to being a planetary laboratory of knowledge and innovation shipped from the rest of the globe (Mavhunga, 2017); such claims are attributed to the silence of African scholars about Science, Technology and Innovations (SCI) happening in African continent and by African innovators (Mavhunga, 2017). Through the Ujuzi app, African providers are able to publish and share their knowledge and skills with the rest of the world.

6.3.1 Exploring Ujuzi App Features

As a brokerage service, the Ujuzi app contains the functionalities possessed by the main actors in the online learning context. They include features tailored to learner and issuers of the micro-learning services. On top of that, it includes features needed to secure and manage the application. Both learners and providers of micro-learning services are supported by the Ujuzi app which collects and stores all necessary information in the specific database. Within the database, metadata concerning each micro-learning unit as well as badges are stored including URL links that connect the resources to their respective host application. In brief, the main features of the Ujuzi app are badges, micro-learning, and partners as depicted in the main interface of the app shown in figure 6-1 below.

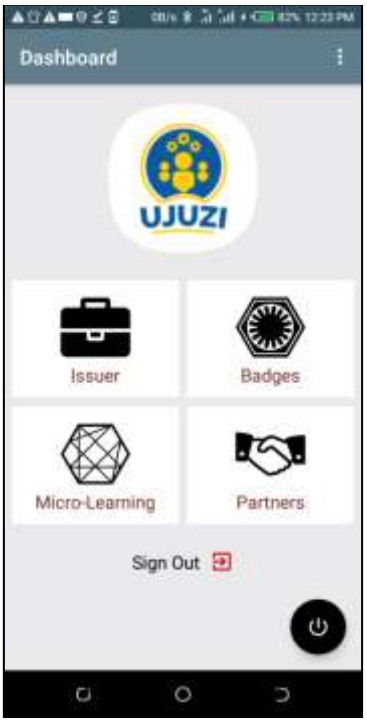

Figure 6-1: Ujuzi app main dashboard

The main screen is composed of issuer, badges, micro-learning and partners as described in the proceeding paragraphs. The four represents the main functionalities of the app. The design of the app, the choices of the logo and icons as well as the arrangement of the services

are meant to guide the users of the app to make intuitive decisions when using the app. First, Ujuzi is a Swahili word that means skill (singular and plural). It signifies that the app's main theme is skills acquisition. Specifically, the world is chosen to awaken the interest of the learner towards not just knowledge but skills. Likewise, the logo was designed to symbolize victory, the trophy. Also, within the trophy are symbols that represent self-construction of skills. Attached in the Annex 6-1 is the list of logo designs that were analyzed by the scholar and the stakeholders.

Second, the icons are chosen from the collection of icons within Balsamiq mockup software. Specifically, we used the briefcase to represent issuer just because we saw the business side of the app. Also, to become an issuer one need to have credibility, ability and commitment to the task. Hence, the briefcase was chosen. Likewise, the micro-learning symbol represents the fact that learning is a network forming process. Hence, the symbol tries to remind the learner to seek skills from various angles as well as providers. Moreover, the badge icon speaks for itself. It represents the digital badges that are given to those who are able to show and prove their achievements and skills. In addition, other symbols are chosen to reflect the respective role and they are commonly used.

Third, the arrangement of the functionalities is well thought by the scholar together with some stakeholders. Because the two main services of the app are micro-learning and badges, in order to ensure they are equally accessible, we placed them next to the issuer. When you look at the main screen critically, the message is clear that the app is broking micro-learning and digital badges from the issuers to learners. Next, we present the details of each service.

6.3.1.1 Issuer

Central to the successful implementation of any learning platform is the content (D'Mello & Achar, 2011). The content and the activities are designed and deployed by the providers (Bruck et al., 2012; D'Mello & Achar, 2011). Technically, providers shape contents to fit the needs of their audience as well as the media to which they will be deployed and used. Generally, providers upload their content within their main platforms or cloud-based services (D'Mello & Achar, 2011). Within the Ujuzi app framework, providers are individuals, organizations or institutions proven to have the necessary skills and knowledge worth sharing with learners. They are the issuers of micro-learning or/and micro-credentials. Through the issuer interface, the Ujuzi app users are able to browse a detailed list of issuers of both micro-learning and badges. Also, the interface offers a link to apply to become one of the

authenticated issuers. Figure 6-2 below depicts the issuer interface of the system as seen by the users.

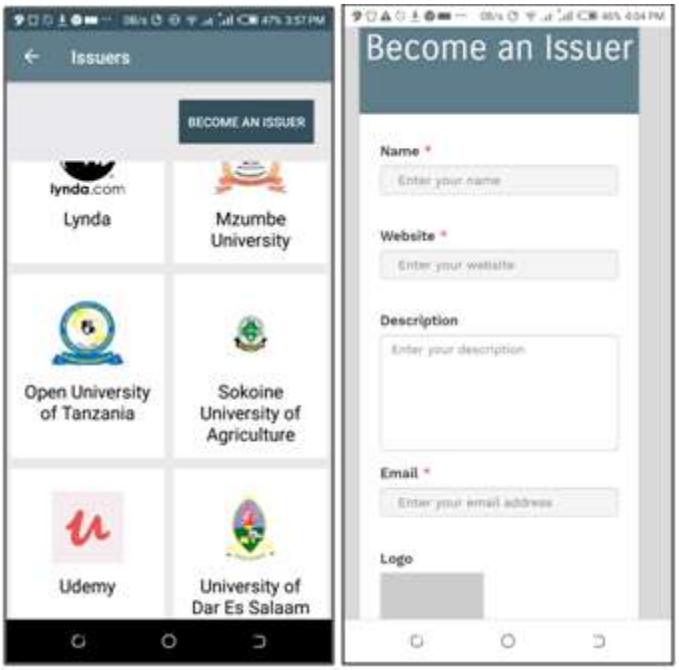

Figure 6-2: Ujuzi app issuer interfaces

The process to become the issuer of the Ujuzi app starts by either sending the application form accessible by clicking "Become an issuer" link in the application or being head-hunted by the brokers who operate Ujuzi app. Once brokers who operate the app are satisfied by the level of the issuer's expertise, the profiles of the issuers are recorded within the Ujuzi database. Then, micro-learning and badges contents belonging to the issuer are registered in the database by using a specialized form accessible by the database administrators (section 6.3.1.6).

6.3.1.2 Badges

The second important feature of the Ujuzi app is the badges interface. While micro-credentials are not highly explored within this work, its relevancy is appreciated by the participants. In the qualitative work conducted in the four universities to explore the expectancy, awareness and readiness towards micro-credentials, it was realized that the university lecturers and students are optimistic that micro-credentials will kindle lifelong and skills-based learning and attract communities outside universities (Ghasia, Machumu, et al., 2018b). Basically, a badge is an image or symbol associated with micro-credits issued to learners to recognize learner's efforts and accomplishment (Davis & Singh, 2015). Unlike other forms of badges, digital badges are embedded with metadata accessible and verifiable by the users of the badge (Dowling-Hetherington, 2017).

Besides, the open badges movement headed by the Mozilla Foundation focuses at making badges inter-operable. Also, the movement democratizes the 'badging' processes to allow anyone with verifiable skills to participate (Priest, 2016). While the use of badges to recognize accomplishment has a long history, badges such as those issued to scouts or military cannot be shared or evaluated digitally (Davis & Singh, 2015). Instead, the concept of the digital badge is relatively, transforming how badges are used by the network societies (Castells, 2004). It is estimated that digital badges emerged around the year 2010 in the United States from people working with the Mozilla and MacArthur foundations (Fong et al., 2016)

The Badges interface offers Ujuzi users the ability to browse the list of existing competencies that users can apply to earn badges. Before applying to earn a badge, the feature enables learners to access the description of all the badges and their associated issuers. At full operation, the badge interface will contain all necessary skills to serve all types of learners from all possible sectors. All necessary badge metadata are stored within the Ujuzi database. Besides, the URL link associated with each badge connects the entry within the Ujuzi database to the issuer's host application. The role of the Ujuzi app is to mediate the exchange of services between issuers of the badges and the learners by providing the platform that allows both to participate in publishing and earning badges. The actual processes associated with issuing and earning of a badge happen within the issuer's infrastructure and platforms. Figure 6-3 provides the interface used by learners and providers to browse the badge list as well as earn them.

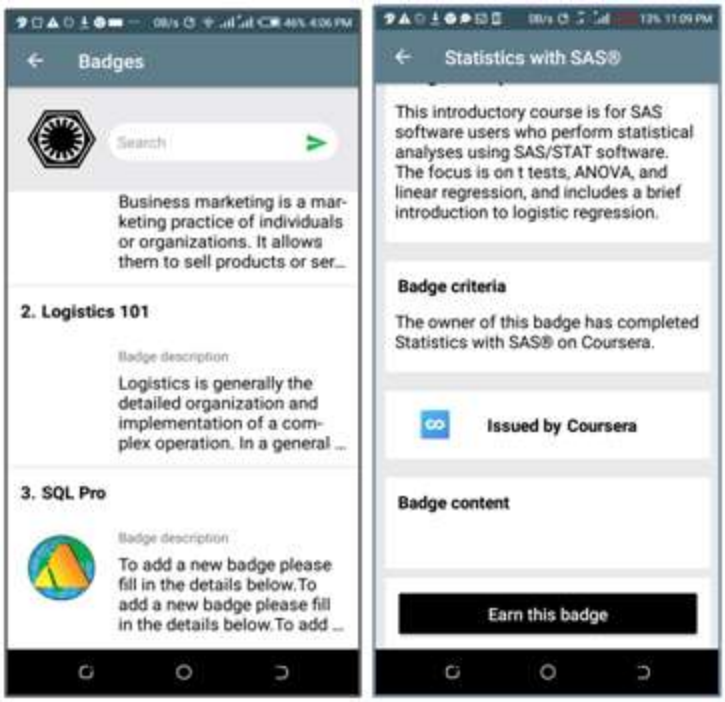

Figure 6-3: Ujuzi app badges interface

6.3.1.3 Micro-learning

While the detailed description of micro-learning as a concept is offered in chapter two, this section describes how micro-learning features of Ujuzi app are used to publish the list of micro-learning offerings by the respective issuers. Ujuzi is a tool used by the learners and issuers to browse details of each micro-learning offering. To simplify the process, the search feature is embedded in the system for users to apply a thematic search. To ensure quality, only contents from the issuers who are evaluated and trusted by the team will be listed in the app. Users of this feature are able not only to access the list of micro-learning offerings but also to access or enrol into a specific course or units. Likewise, all necessary and available metadata are stored within the Ujuzi database. The metadata include URL links associated with each micro-unit, connecting the entry within the Ujuzi database to the issuer's application. The role of the Ujuzi app is to bridge the navigation gap between the issuer of the badge and the learner by providing a platform that allows both to participate in the micro-learning service exchange. Particularly, the actual processes related to the enrolment and participation including payments for the course happens in the issuer's infrastructure and platforms. Figure 6-4 provides the interface used by learners and providers to browse the list of micro-learning offerings embedded with URL links used by learners to enrol into a particular offering.

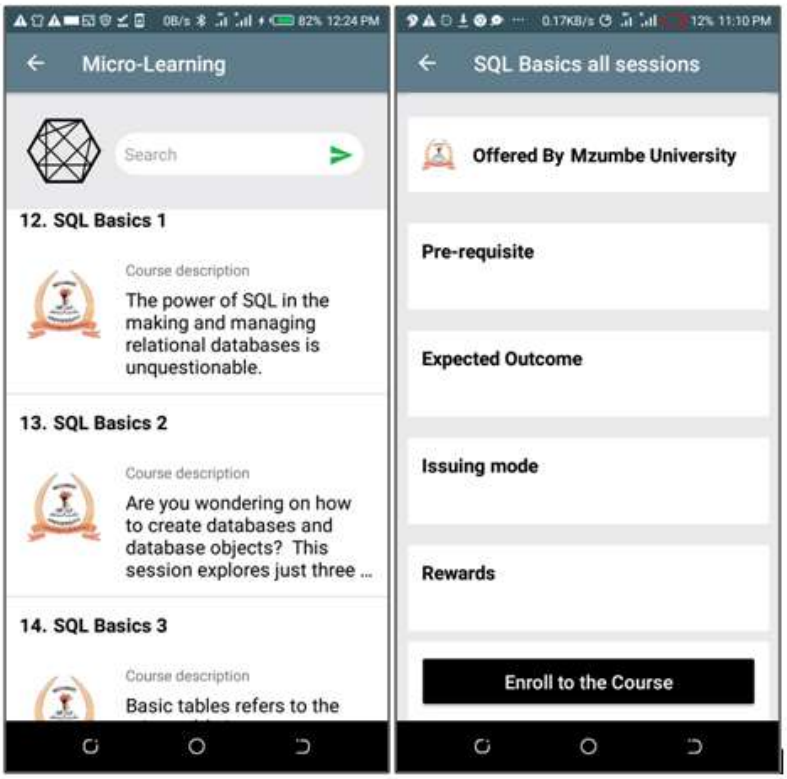

Figure 6-4: Ujuzi app micro-learning interface

6.3.1.4 Partners

Sometimes course offerings are collaborative in nature, it is possible for the issuers to partner with other organizations in offering micro-learning content as well as badges. This feature recognizes partners that support specific micro-course or badges within the system. The description of each partner and their role is provided within the system and stored within Ujuzi database.

6.3.1.5 Authentication

Ujuzi users are authenticated before they can access the services. Currently, users are authenticated by using credentials they receive after registering into the system. In fact, the current arrangement allows anyone to register through mobile or web interfaces.

Process:

a. User fills in the registration form. At a minimum these metadata are requested:

{firstName, Surname, Sex, Birthdate, Email, Password (preferred security), location, occupation).

b. A database entry is created in a user database table. User will be prompted to confirm the account through emails provided.

c. In order to login into the system, users enter username and password. Then the details are sent to the database. The details are compared against the existing combination of passwords and usernames (in this case the email address).
d. If the corresponding entries exist, the user is allowed to access Ujuzi services.
e. If the details do not match, users are reminded to verify the details or create an account if not yet done.
f. In addition, mobile users have an option to make if they want to sign-out after each session or remain logged until further notice (see annexe 6.2), in the future, we will explore other authentication options.

6.3.1.6 Metadata Storage

Metadata refers to data about data. For example, sex is a metadata that describes an individual is either female or male. In order to accomplish the intended responsibilities, the Ujuzi App stores data collected through metadata. Currently, the App contains a minimum number of metadata concerning issuers, learners, micro-learning, badges and partners. Below is the list of metadata stored in the database and how they are associated with each other. It is practically okay that, during the actual use, more metadata concerning the prevailing needs will be added.

The metadata kept by the system are as follows:

Issuers:

- Name of the issuer for identification;
- Email Address for contact
- Detailed description of the issuer up to 1200 characters
- Logo and the website Address offers learners a chance to learn more about the Issuer through their websites.

Users/Learners:

- First and Surname of the learners for identification,
- Sex and birthdate for identification and data manipulation in the future
- Email Address, Location (City, Country) and passwords for authentication as we described in the previous section.

Badges:

- For the ease of access, we provide each badge a unique identifier, an automatic number generated by the system.

- Title of the badge, description and criteria needed to earn the badge.
- The “dateentered” records the date that issuer is registered in the database. Also, we store issuerId of the Issuer. The “issuerId” is needed to associate each badge with the owner.

Micro-Learning:

- MicroLearningId is the unique identifier of the records. It is automatically generated by the system.
- IssuerId is kept to associate micro-learning contents with their respective providers.
- Title and description of each micro-learning are stored
- PreRequisite defines the minimum requirements that learners need to enrol in a particular micro-learning
- Mode of delivery as well as awardOnCompletion are stored to inform the learner on the outcome of the course.

Associations between Records

As figure 6-5 reveals, data in one table are associated with the related data in another table. Each of the tables is linked to another table to simplify data retrieval. Specifically, the diagram lists the following direct relationships.

i. One issuer’s record is associated to one or many badges. That means one issuer can issue or store one or more records concerning badges at the same time.
ii. One issuer’s record is associated to one or many Micro-learning. That means one issuer can issue or store one or more records concerning micro-learning at the same time.
iii. One learner can be associated with one or more micro-learning claims. Means there is no limit when it comes to enrolling or earning badge (s).
iv. A partner can be part of one or many items he /she support and vice versa.

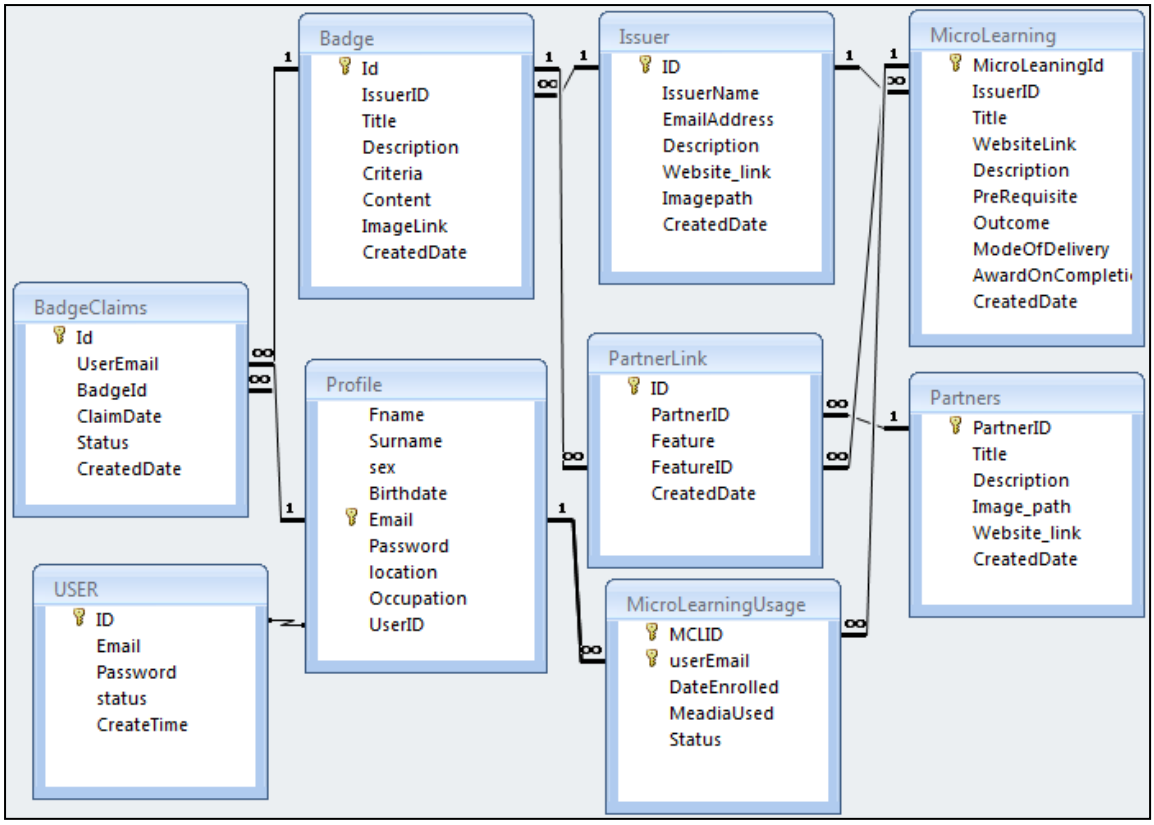

Figure 6-5: Ujuzi App Database Schema

Retrieving Information from the Database

To retrieve data from the database one need to send codes to the database through a database management system (DBMS -in this case, MYSQL). Depending on the type of data that one needs, the usual scenario is when user type search term either in a web or mobile interface the keyword is embedded in the SQL commands and sent to MYSQL. Some queries are directed at one table while other queries require joining more than one table. For example when a leaner want to retrieve information concerning the available micro-learning contents, at the event of clicking micro-learning icon in the mobile the following query is activated automatically because the icons on the screen are embedded with commands that communicate to the DBMS:

MYSQL>SELECT TITLE,DESCRIPTION,IMAGELINK

FROM MICROLEARNING ORDER BY TITLE;

The result of this query is presented in figure 6-4 above.

However, if the leaner want to retrieve micro-content concerning “content creation” or any specific topic, as soon as they submit the form with the keywords, a modified version of the query is created as follows.

```
MYSQL>SELECT TITLE,DESCRIPTION,IMAGELINK
FROM MICROLEARNING
WHERE TITLE LIKE '%CONTENT CREATION%'ORDER BY TITLE;
```

The result for this query will be a list of courses that have words “content creation” within their titles.

The above is a brief description of data retrieval. The queries we have demonstrated runs quiet fine, and when results are retrieved, the application logic and the presentation layer format the retrieved data into usable form. As the database grows more sophisticated approaches to organize data will be used including partitioning of the database. Through partitioning, data are logically divided based on a number of criteria based on the available performance indicators. For example, if someone from the city of Gent search immigration database of Belgium, the query is directed to a partition that contains data related to gent.

6.3.2 Ujuzi App Designs

As described in the methodology part of the document, the Ujuzi application is made of two versions: the mobile and web-version. The decision to have both versions is influenced by the findings from our preliminary study (Ghasia, De Smet, et al., 2018a) that revealed that the majority of students cannot afford mobile technologies contrary to what has been portrayed by the previous scholars including (Mtebe & Kandoro, 2016; Mtebe & Raisamo, 2014). It was discovered that students rely on insufficient student loans known as “boom”, provided by the government to buy smartphones. Because the amount is not enough, and because of unsatisfying infrastructure, students sacrifice their lunches and stationeries just to buy a smartphone to help them with communication as well as connecting to the Internet for scholarly resources. Moreover, because of the financial and technical challenges, it is sensible to provide learners with alternative means of access to the application to ensure continuity of service at times when one of the versions cannot be accessed due to various reasons. The two versions are synchronized and use the same Ujuzi database and features described in the preceding sections.

6.3.2.1 The Ujuzi App Architecture

Figure 5 presents the core architecture of Ujuzi app. It is composed of three main components that are organized in a three-tier-architecture. The three-tier-architecture is made of the presentation, application and data layers also known as tiers.

- The presentation layer also known as the user interface of a web-based or mobile-based application refers to the front-end application that users interact with. In most cases, it is the graphical user interface such as the website pages or mobile application pages that users always use to interact with the system. The role of the front-end applications in the presentation layer is to format and present application data to the users in a user-friendly format. For example, when we open the webpage say www.amazon.com, the appearance of the page, look and the colours are the result of the presentation layer applications. They translate the codes from the designer and embed data from the database and organize accordingly. Hence, in most cases, the way the data appears in the web-page or app interfaces are different from how they are arranged in the database. Moreover, the front end applications are developed by using browser-aware languages that interact with the application logic for information. The retrieved information is then processed by the browser and presented in a format that can be easily used by the respective users. In this project, the Ujuzi app is comprised of the mobile and web interface. The two interfaces are developed by using HTML, Java Scripts and XML languages.
- On the other hand, the application logic is the core layer of the three-tier-architecture. It is in this layer that business logics and processes are performed. The core of Ujuzi is written in PHP and Java languages. It is at this stage that all the actions performed by the users are translated and committed against the database in the Data tier. For example, when the user submits a search keyword in a search form in a presentation layer, the keywords are taken by the application layer application and convert them into a database query and send it to the database management systems (DBMS) to retrieve the results. Likewise, the results from the database cannot be understood by the users unless they are presented in the right format. Hence, the DBMS send results to the application layer for processing, Once they are processed, the application data sends the results to the presentation layer. In the end, the results are converted and formatted by the front-end applications to ensure they are readable by the users.

- The data tier is responsible for data management. They consist of databases that store the data of a particular application. For example, all customer records in an online system such as the Amazon are organized, stored in and retrieved from the database. Within the database, data might be organized in tables or other formats. The Ujuzi database is based on MYSQL database server. It stores all the data related to learner, issuers, badges and partners. Also, for the management and control of the system, all the transaction logs reside within the database.

The three-tier-architecture provides an independent way of dealing with different components of an application. For example, it is possible to maintain the database, presentation code and business logic separately. For example, any change in one of the components, e.g. database software, does not impact the other layer, as illustrated in Figure 6-5.

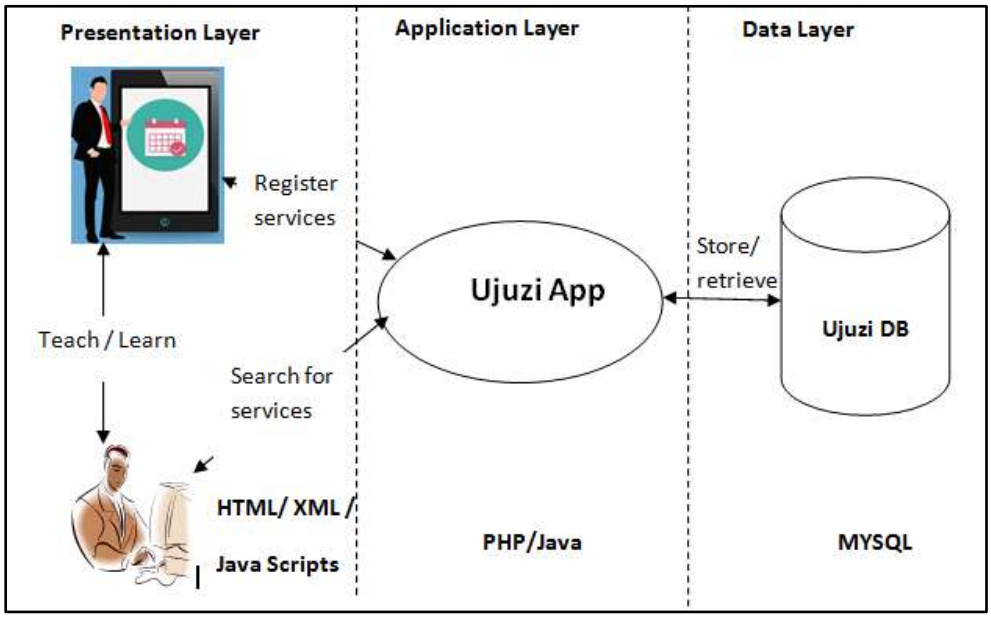

Figure 6-6: Ujuzi App Architecture adapted from *(D'Mello & Achar, 2011)*

The three-layer architecture of the Ujuzi app determines how each component of the application is developed and related to another. The presentation layer represents the app interfaces that learners, issuers and other users interact with. Through the interface, one can send a request to become an issuer or browse list of issuers. Once one is accepted as an issuer, they can register their services in the database by the aid of the Ujuzi forms. The Ujuzi forms are part of the presentations layers. In order to update the database, the forms are converted by the Ujuzi application logics within the application layer before they can be affected in the database.

Likewise, through the interfaces, prospective learners search the content of the database for micro-learning and digital badge offerings. In the same way, we send search words on

Google, the words are converted by the application logics before they can be used to query the database. Hence, all learners' requests start at the interface through the application logic to the database. The results from the database are converted by the application logic to fit the users need and interface.

Further, in order to understand how different actors of the app interact with the system, the use-case-diagram is the ideal tool used in software engineering. Figure 6-6 below is the use-case-diagram of the Ujuzi app; it provides the detailed depiction of the key activities performed by actors while using the application.

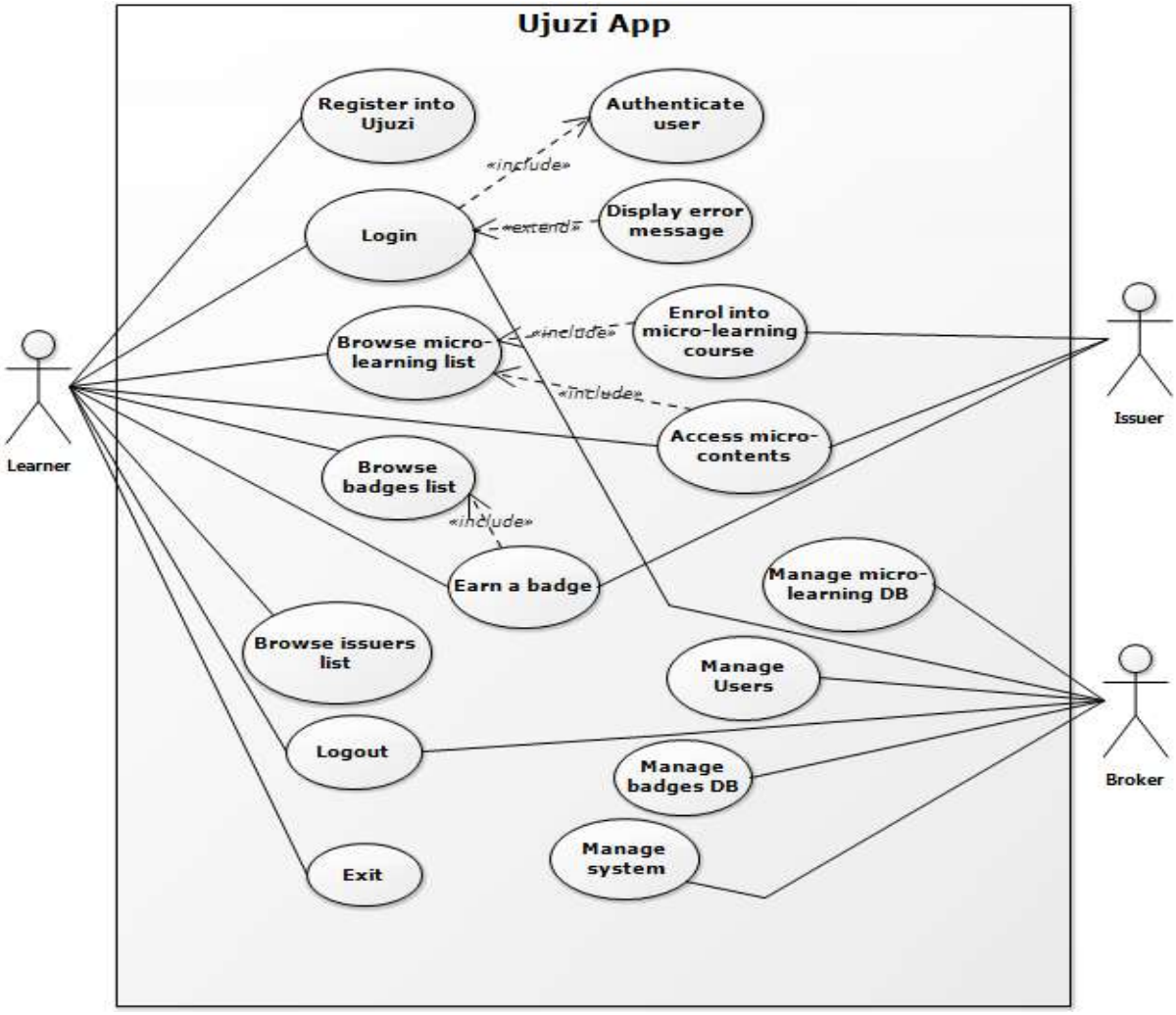

Figure 6-7: Use case Diagram for Ujuzi App.

The figure depicts the summary of Ujuzi app activities based on the users of the system. The rectangular box represents the Ujuzi app system. Also, in the oval shapes are the activities those particular users are able to perform in the system. The human shapes represent the actors (users) of the system. The lines represent an association between the user and the action. Also, extend and include associate a certain action with the other. For example, when

learner login into the system, the ‘authenticate user’ is performed immediately by the system after they have clicked the log in button. Likewise, the include actions are performed prior to performing a certain action. For example, learners are only able to enrol into a course after they have browsed the course list. Hence, the following actions can be summarized by the actors in the system:

Learners are able to:

- Register into the system
- Login into the system after they are authenticated
- Browse list of micro-learning contents
- Enroll into micro-learning courses after they have browsed micro-learning list
- Browse list of badges
- Earn badges after they have browsed badge lists
- Logout from the systems
- Exit (quit) the application

Issuers are able to (being in the right of the system means they can offer the same services):

- Browse list of issuers as well as becoming issuer as well
- Browse list of micro-learning as well as being issuer as well
- Issue and earn badges from others
- They can log in, logout, and quit the system as well
- Broker refers to the experts who are in charge of the system. To be able to work with the system they have to log in and logout. They are in charge of the system operations:
- Logon into the systems’ back end systems
- Manage user; deleting, adding, deleting, suspending users (learners, issuers, others)
- Managing badges database; deleting, adding, deleting, updating badges
- Managing micro-learning database; deleting, adding, deleting, updating badges
- Managing the entire systems

Hence, the overall operation of the app depends on the performance of the stakeholders involved.

6.3.2.2 Ujuzi Deployment

One of the key attributes of the Ujuzi design is its ability to be deployed in any higher learning institution across the globe. The core design of the app is not biased to fit a specific institution or society, the names, colours as well as the attribute names and constraints are formulated without abiding by certain institutions. As discussed in the methodology chapter, the Ujuzi app is experimented with and tested at Mzumbe University by involving students, education technologists and academic staff. Due to the limited time and resources, the app was used to deploy micro-learning content to the students taking database subjects (database and database systems, SQL and database backup) as illustrated in the previous sections. Specifically, we created contents for the topics in the database. Thus students who take ICT related courses benefited from this.

Initially, the researcher introduced Ujuzi app to students and their lecturer in class. They were introduced to micro-learning and micro-credential concepts before being inducted into the system features, both mobile and web versions of the application. Then, students were asked to voluntarily participate in using and evaluate the efficacy of the application by using any of the available versions. In order to participate, students downloaded the application from the Google Play Store as well as using the web version. Then, they registered in the system before they could access micro-learning contents. The administration portal of the system provided the scholar with the dashboard to monitor the progress of the system access. Later, students who used the system for a prolonged period of time filled the survey forms adopted from the survey monkey to evaluate the system features and attributes to uncover attitudes of the users. Figure 6-7 below depicts media used by students to access the application.

Similarly, the application was evaluated by the team of experts to identify its relevance and efficacy. They included academic staff and education technologists at Mzumbe University. The process involved downloading and installing the Ujuzi app from the Google Play Store into their Android phones and then to explore the system features including access micro-learning contents. Unlike the students, the education technologists did not need to be inducted into how to use the app; instead, the researcher explained to them the overall theory behind micro-learning and brokerage service deployment. Afterwards, participants received evaluation forms in both hard-copy and digital copies available from the Google Forms services issued through Mzumbe University Google apps services that include the university e-mail services.

There are two ways that the Ujuzi app can be used within the university settings:

- First, as a gateway for students to acquire specific skills for their career. In this way, lecturers use Ujuzi app to recommend relevant skills-based content from across the globe to their students. Instead of searching the Internet, students traverse through the recommended nodes for the right contents. The recommended contents aim at complementing the existing curricular delivered through either traditional or e-learning approaches. Secondly, Mzumbe University, like any other institution can use the Ujuzi app as the platform to market and publish micro-learning services to the wider communities. For owning brokerage services like Ujuzi, the institution becomes a hub of micro-learning services and the associated transactions. These transactions concern various providers. In this experiment, the Ujuzi app is used to mediate micro-learning services that complement the traditional face-to-face approach. Voluntary involvement of students and staff in this setting reflects the principles of Connectivism. In Connectivism based learning learners take initiative to learn from various sources available across the globe. Also, Just like lifelong learning, learners voluntarily choose when, where and at what pace to learn.

6.3.3 Assessment of the Ujuzi App

The methodology chapter provides detailed descriptions on how the artefacts including the Ujuzi app were developed and evaluated by stakeholders. To date the app is evaluated by 105 users, in total, consisting of students, technology experts and academic staffs. Specifically, seventy-five students and nine education technologists returned filled-in survey forms. The survey collected data related to users' reactions concerning the system features, designs, relevancy and attributes of the app. Further, data related to the attitude of the respondents in relation to the contributions and needed improvements were collected. Particularly, respondents were required to respond to the ability of the app to facilitate and or improve skills-based learning as well as shortening time required to access quality contents. On top of that, focus group discussions with educators and students were held to evaluate the app. In the coming paragraphs, we present the settings of the exercise and discussions of the results of the assessment.

6.3.3.1 Participants

As described in the previous section, the Ujuzi app was introduced to the diploma and degree students who are taking database subjects. They include Bachelor degree in Library and Information Management (LIM 3), Bachelor degree in Information Technology and Systems

(ITS), Bachelor degree in Information Technology with Business (ICTB), Bachelor degree in Information Technology with Management (ICTB), Diploma in Information Technology (DIT) and Master of Arts in Education (MAE). Specifically, MAE students were involved to bring in their educational perspectives of the app as the majority are from the education sector. In particular, they recommended the extension of the app to target pre-university levels too. In particular, seventy-five students voluntarily participated in the evaluation of the app of which 53.3% are female. Also, the majority (50.7%) of the respondents identified themselves as having intermediate ICT skills whereas 28% and 21.3% were experts and beginners respectively. On top of that, nine ICT experts from the Directorate of Information and Communication technologies (DICT) conducted the technical assessment of the app. In addition, results reveal 58.6% of the respondents used the app on the mobiles (tablet and smartphone), 13.3% accessed the web-version of the app on the computers whereas 28% accessed the app by using a combination of the media such as computer and tablet or tablet and smartphone. The pie chart below signifies the need modularity of the app so that users are given a chance to make use of the system in any media they may feel comfortable to use.

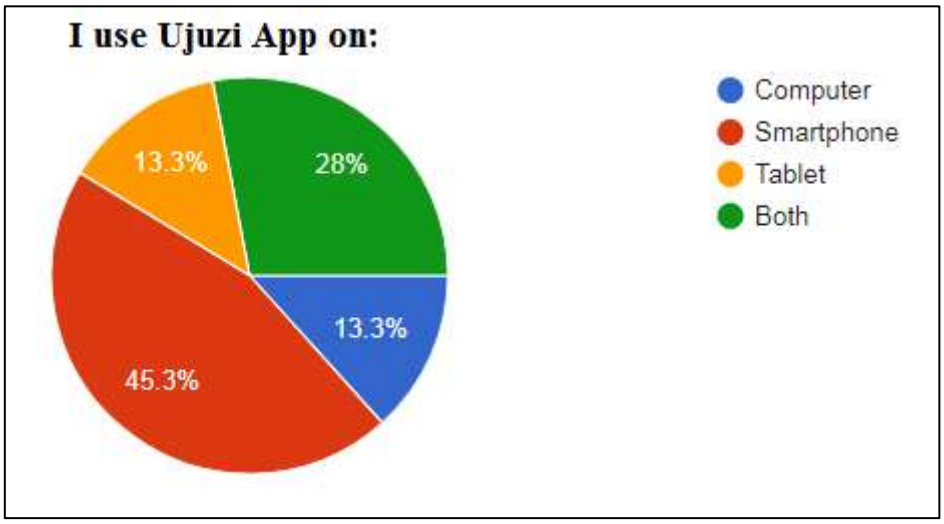

Figure 6-8: Students use Ujuzi on these devices

6.3.3.2 Instruments

The primary instrument used in the evaluation of Ujuzi is the survey form, attached at the back of this dissertation (Annexe 6.3). Two different versions of the survey forms were issued to students and ICT experts. The instruments were adopted from the Survey Monkey website (https://www.surveymonkey.com). In fact, Survey Monkey is a company as well as cloud-based survey software that offer survey-based tools and questionnaires that enable people across the world to adapt and use accordingly (Waclawski, 2012). To adapt to our

case, the questions were improved by re-wording, adding and removing unnecessary items. As a result, the student evaluation form consists of nine questions while the ICT experts' form consists of thirteen. The survey consists of both open-ended and closed questions. The questions are categorized in two groups:

- The first group consists of the participants' personal description.
- The second group deals with experience and reactions towards Ujuzi and its features. This includes questions tailored towards weaknesses, areas of improvements as well as general recommendations for the application.

In particular, the evaluation forms were available in print and digital forms. The print forms were issued to respondents by me directly or through student representatives while the digital version was sent to students and staff through emails. The digital version was developed by using Google Forms. The advantages of using the Google Forms are: you can track the progress of the exercise as well as the analysis of the data is automatically done and both respondents and scholar are able to access the results on demand (Chaiyo & Nokham, 2017; Gehringer, 2010). Also, it is easy to export data from the forms into spreadsheet software in various formats including comma-separated values (CSV) (Gehringer, 2010).

The students' evaluation form consists of nine questions, open-ended and closed. On top of the questions that collect personal information of the respondents, there are questions concerning the experience and perception of the students in regards to Ujuzi. Core questions of the survey concern the attitude of students in using the application. They consist of two Likert scale questions. Participants respond to the survey by making the choice that corresponds to the degree of agreement or disagreement to the Likert items. Likert items collectively contribute to measuring the attitude (Rubaish, Wosornu, & Dwivedi, 2011). The Likert scale is widely used to measure the attitude of the respondents towards various phenomena (Rubaish, 2010). The first Likert scale question consists of twelve items about Ujuzi features and design. For example, students were asked to respond to "how ease is the language of the app" as well as "how confident are they in using the app". The second Likert scale question consists of eight items collecting responses related to the usefulness of Ujuzi app. Together, the open-ended questions expand on the Likert questions to explore areas that need improvements as well as recommendations from the respondents.

As for the experts' evaluation form, it consists of nine main questions, open-ended and closed. Some of the questions have sub-questions that allow the experts to offer additional comments and information. For example, the experts were asked to answer if the app

answered all of his/her/their questions about the topics; if the answer was "no", in the following question, experts were required to provide the unanswered questions. Overall target of the experts' evaluation is to make a technical assessment of the Ujuzi app. Technical assessment from the experts combined with users' assessment and attitude towards the application help to uncover the suitability and usability of the tool. Together with evaluation forms, we conducted interviews with experts and some students to clarify important issues from the feedback. During the interviews and in the survey, both experts and students were able to share their attitude and feelings on the application as detailed in the results section.

6.3.4 Data Analysis

The responses from both ICT experts and students were analyzed separately through a combination of methods. The open-ended questions were subjected to thematic analysis to identify key concepts and messages whereas the Likert scale questions were analyzed statistically. The prominent methods used to analyze Likert scales are arithmetic mean, median, quantile and cumulative percentage (Rubaish et al., 2011). Because Likert scale items are ordinal, we used cumulative percentages to analyze them. Specifically, cumulative percentages are more appropriate for ordinal data than mean, median and percentile because it is easier to comprehend and to apply (Rubaish, 2010). The problem with the arithmetic mean is that it includes the measure of the neutral position in its computation. The cumulative percentage approach deals with the acceptable score 4 or 5 only. The cumulative frequency was used because through analysis of acceptable scores it is easy, clearer and straightforward to determine the acceptability of Ujuzi app and to avoid the impact of the neutral scored from interfering with the result as it is in other methods.

The outcome of the analysis can be categorized into three groups: the high-quality attitude is achieved if the participant or the domain of the survey obtains a minimum of *eighty percentages* cumulative. The 'acceptable', also known as 'good' attitude is achieved when obtained a cumulative outcome *between sixty and eighty* percentage inclusive and exclusive respectively (Rubaish, 2010). Any outcome that falls below sixty percentages is poor and requires improvement. Alternatively, if the value falls short of 60%, the attitude of the respondent to a domain is low and if the value is 60% and above, the attitude is high (Rubaish et al., 2011). Table 1 below provides summary results of the Likert scale analysis of students and experts' data.

Results: Attitute Towards Ujuzi App		
Item	**Cumulative Percentage of 4&5 (%)**	
A: Ujuzi App Features	**Student**	**Experts**
I found this app easy to use	83	100
I can use it without written instructions	75	78
I can navigate through the app easily	79	100
The language used in the app is not difficult	72	100
The app is difficult to work with	69	
Using the app was an enjoyable experience	79	89
The app is unnecessarily complex	52	
I think that I would use this app frequently	80	78
I feel very confident using this app	87	89
The app works the way I would want it to work		44
The app is designed for all levels of users		33
B: Ujuzi App Attributes		
The app shortens time needed to search for content from the Internet	80	
The micro-learning contents are easy to remember	88	
The app leads us to quality content	81	
The app leads into skills improvements	77	
I support the idea behind Ujuzi app development	87	
I would recommend this app to a friend	88	

Table 6-1: Respondents' attitude towards Ujuzi App

6.3.4.1 Data Reliability

It is recommended to conduct a reliability analysis of the internal consistency of a Likert scale before that scale can be translated into actual research findings (Gliem & Gliem, 2003). There are several measures of internal consistency including Split-half and Coefficient Alpha also known as Cronbach's alpha (Streiner, 2003). Of the two measures, the latter is widely used to measure the internal consistency of a Likert scale as it is more reliable and convenient to use because it requires only a single test to obtain results. In principle, Coefficient Alpha is the mean value of reliability one would obtain after carrying out the same test at a number of times (Gliem & Gliem, 2003; Streiner, 2003). Normally, the value of the alpha ranges between 0 and 1, however, there are cases when the value fall to negative (Gliem & Gliem, 2003; Streiner, 2003). The acceptable rule of thumb is that all scores above 0.6 and acceptable to allow researchers to have a true reflection of the score for the scale (Gliem & Gliem, 2003). In practice, during analysis, if some questions are not well correlated with the rest, they are removed to improve consistency level.

This work applied Coefficient Alpha to analyse the reliability of the internal consistency of the three scales. The first scale concerns the attitude of students towards the Ujuzi app design. Specifically, students were asked to provide their reactions about their experience in using the

app. The scale had a total of twelve items. The first reliability test conducted at the scale revealed a Coefficient Alpha of .614. In order to standardize the score, we removed three items (5,6 & 10) as they poorly correlated with the rest as it is the practised and recommended by scholars (Panayides, 2013; Warrens, 2015). The repeat of the test revealed .708 coefficients which is acceptable for the analysis of the scale. The second scale concerns the attitude of students towards Ujuzi usefulness. Specifically, students were asked to provide their attitude about the value of the app for the society. The original scale had eight items. The first reliability test conducted at the scale revealed .437 coefficient alpha. In order to standardise the score, we removed three items (5&6) as they poorly correlated with the rest. The subsequent test, after removing low correlating questions, revealed a .782 coefficient which is acceptable for the analysis of the scale as shown in Table 6-2 below.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.782	.787	6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1	20.47	9.009	.448	.476	.774
Q2	20.49	8.902	.644	.545	.723
Q3	20.65	9.067	.565	.476	.741
Q4	20.53	9.468	.549	.381	.746
Q7	20.41	9.732	.403	.601	.779
Q8	20.37	8.480	.606	.630	.729

Table 6-2:Result of the reliability test of students second scale

The third scale determines the attitude of experts to the Ujuzi design. Specifically, they were required to provide their assessment concerning the design of the app. The scale had a total of thirteen items. The first reliability test conducted at the scale revealed .687 alpha. Then, two items (10&11) were removed as they were poorly correlated to the rest. The following test revealed .802 coefficients which is good for the analysis of the scale. The resulted questions were analysed as detailed in the next section.

6.3.5 Discussion of the Results

Critically, it is important to study users' perceptions about a given technology in order to predict their intention to use it (Dibra, 2015; Mtebe & Raisamo, 2014). Literature suggests two main aspects that contribute to the usage of technology: usefulness and ease of use (Dibra, 2015; Fichman, 1992). Both aspects are linked to the design of such technology, however. On the one hand, the ease of use is linked to the efforts associated with using technology (Lee et al., 2003; Venkatesh et al., 2003). On the other hand, the usefulness is linked to the value inscribed within the design (Feenberg, 2005). Much of the debates concerning technology revolve around the value of technology, the functionalities and affiliated side effects (Allen-Brown & Nichols, 2004). The belief that technologies are autonomous and oppressive forces versus neutrality of technology has been discussed in chapter 2 of this document. We adhere to the critical theorist camp believing in the co-creation and democratization of technology designs and development processes (Allen-Brown & Nichols, 2004).

In the coming sections, we discuss the findings from the evaluation exercises performed on the Ujuzi app. particularly, we present the attitudes of the students and experts towards the application features as well as its implementation in the university environments.

6.3.5.1 Attitude to Design and Experience of Ujuzi Features

Table 6-2 above and Figure 6-8 below provide snapshots of respondents' reaction towards the Ujuzi design. They are what Ujuzi users feel of the Ujuzi features based on their experience with the app. Overall; users have an acceptable or positive attitude towards the design of the Ujuzi interface and features as reflected by a cumulative percentage of above 60% for both experts and students.

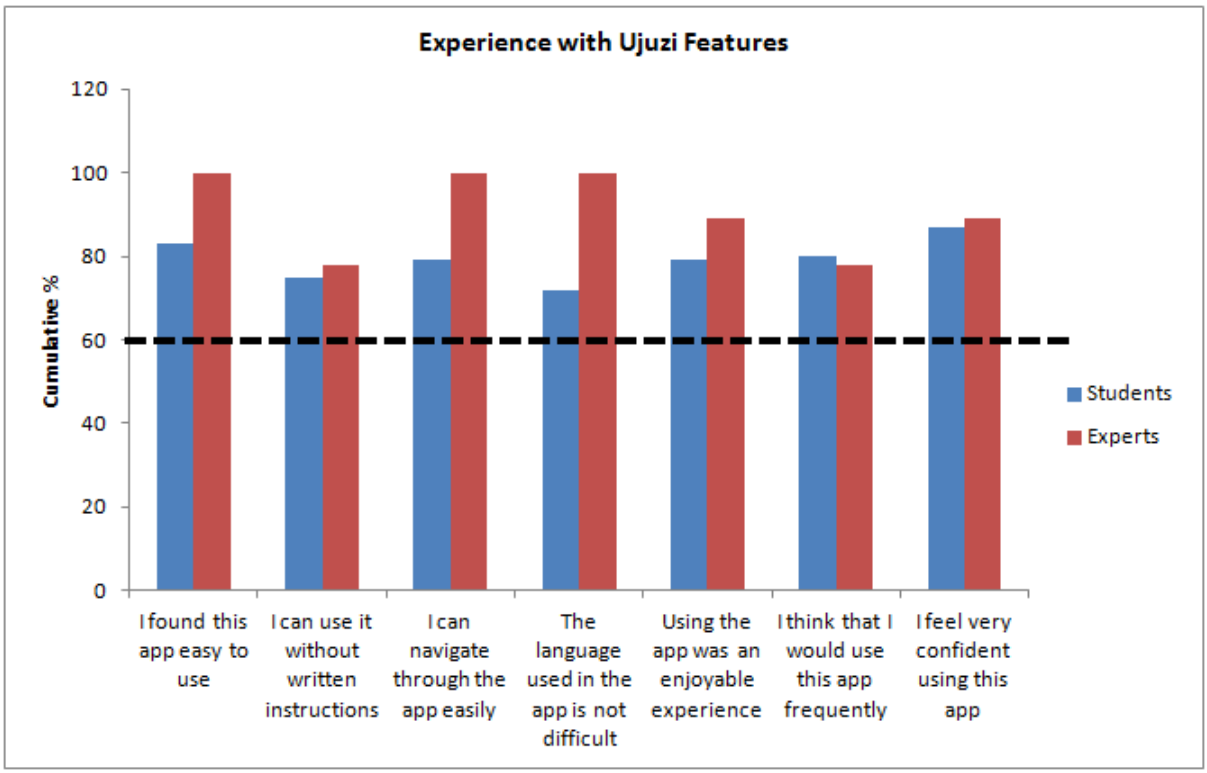

Figure 6-9: Respondents attitude towards Ujuzi features

Specifically, both students and experts find Ujuzi to be easy to use (student - 83%, experts - 100%). In particular, they find the app features intuitive. They can use it without written instruction (75%, 78%). Similarly, it is uncovered that the app's design is simple which makes it easy to navigate through (79%, 100%). Also, the language used is simple and clear to users (72%, 100%) in such a way that it raised the confidence of the users (87%, 89%). As a result, both sets of respondents are satisfied with the experience as they reflect on the use of the app as an enjoyable experience (79%, 89%). Hence, they feel ready to use the application frequently. The above feeling can also be found among the comments from the respondents including this one "*The app is well designed and performs well. The idea behind Ujuzi is relevant for society*".

However, as it is well known that there is no perfect design in the world, the Ujuzi app is not exempted from limitations. As reflected in Table 1, respondents are not satisfied with one design of Ujuzi feature: it lacks a Swahili version. For Ujuzi to be effectively used by users at all levels in Tanzania, language plays a significant part. Therefore, it was recommended to create a Swahili version too. Also, during interviews and focus group discussions as well as the open-ended questions of the survey, it was recommended to add a feature that will enable collaboration and interaction between learners and providers. One of the comments from the

respondents reads like this: "*The app must contain group discussion features to allow users to discuss different issues" (male, 34, MU, 25/3/2019).* The discussion of the limitations is provided in the following respective sections as we proceed.

6.3.5.2 Attitude to Ujuzi App usefulness

The relevancy of any technology is judged by its ability to solve social problems or improve the existing situation in a business or society (Dibra, 2015). Regardless of how well the design of a given technology is, if it is not able to positively contribute to members of society, such technology may remain unused. Users in search of a particular solution constantly compare and evaluate the actual usage against the expected outcomes. If the technology fails to fulfil such demands, it is likely that they will protest or boycott. Ujuzi users were asked to evaluate the efficacy and affordances of the app. The table1 above provides the results of the analysis performed on data collected through a five-point Likert scale and discussed hereunder. In general, the results of the analysis indicate that students score a *highly positive attitude* on the usefulness of the app as reflected by the *eighty-seven percentage* cumulative percentage. Specifically, users believe that brokerage services such as Ujuzi combined with the micro-learning approach are transformative forces in education; they facilitate skills-based and lifelong learning as well as offer needed flexibility, learning "anywhere", "anytime" and at "any-pace".

In particular, the respondents believe that Ujuzi app shortens time (80% cumulative percentage) to access micro-learning content as compared to learners searching the Internet. Specifically, the Ujuzi architecture exempts users from searching the public Internet; instead, all users search are directed to the private Ujuzi database; hence it is direct and shortens time. Figure 6-9 depicts students' reactions to the Ujuzi app concerning time-saving. Note: A=agree, D=disagree, SA=strongly agree, SD=strongly disagree, and N=neutral in all of the figures to come).

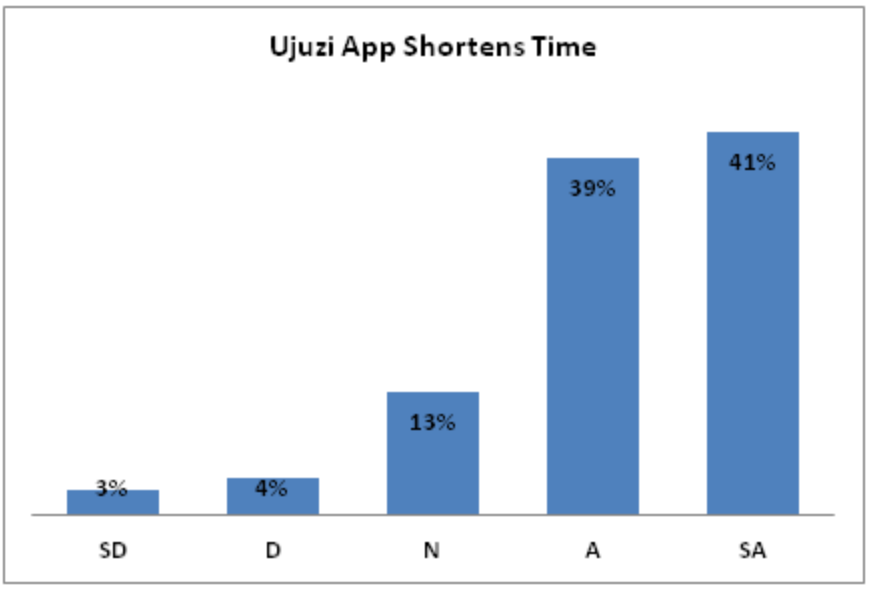

Figure 6-10: Students reaction to Ujuzi App

Similarly, a high number of the respondents (81% cumulative percentage) believe that Ujuzi contributes to the quality content delivery. Unlike the public Internet, through Ujuzi only trusted providers are allowed to offer their micro-learning offerings. It is the responsibility of the implementing institutions to devise strategies and set criteria used to evaluate prospective issuers. The responsibility of the Ujuzi experts (is to define criteria used to identify and recognize the issuers of the content. This approach guarantees the availability of quality and relevant content to the learners. For more detailed analysis on the matter refer to table1 and figure 6-10 below.

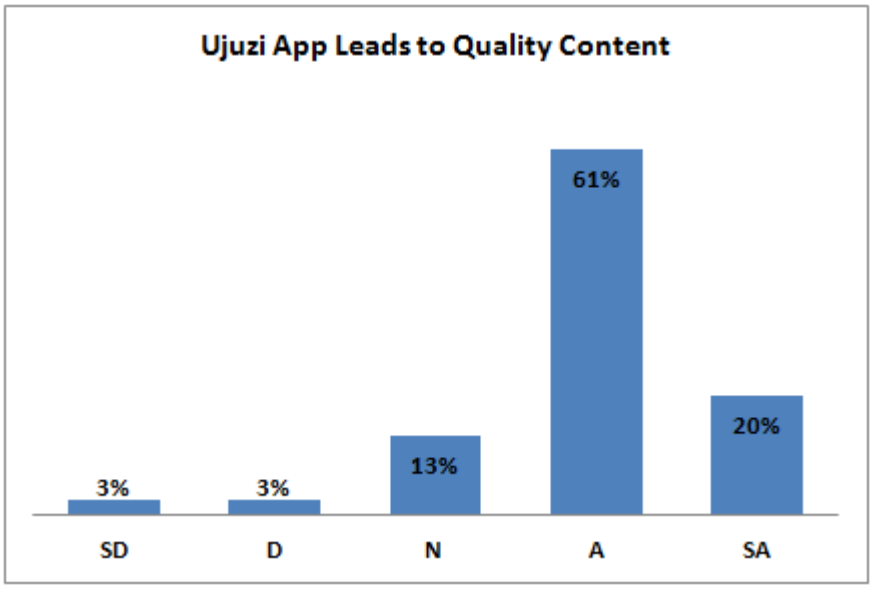

Figure 6-11: Students reaction to Ujuzi App

Moreover, a good number (77% cumulative percentage) of respondents believes that the Ujuzi app implementation will facilitate skills-based learning and hence impart skills onto

learners. As previously described, the app is developed to mediate relations between providers and learners. In principle Ujuzi neither offers content nor assessment tools. However, its roles are limited to simplifying access to quality resources. Therefore, indirectly, the app contributes to skills acquisition through delivery of micro-units because the majority of micro-content is skills-based in nature. Figure 6-11 provide details from the respondents' perspectives.

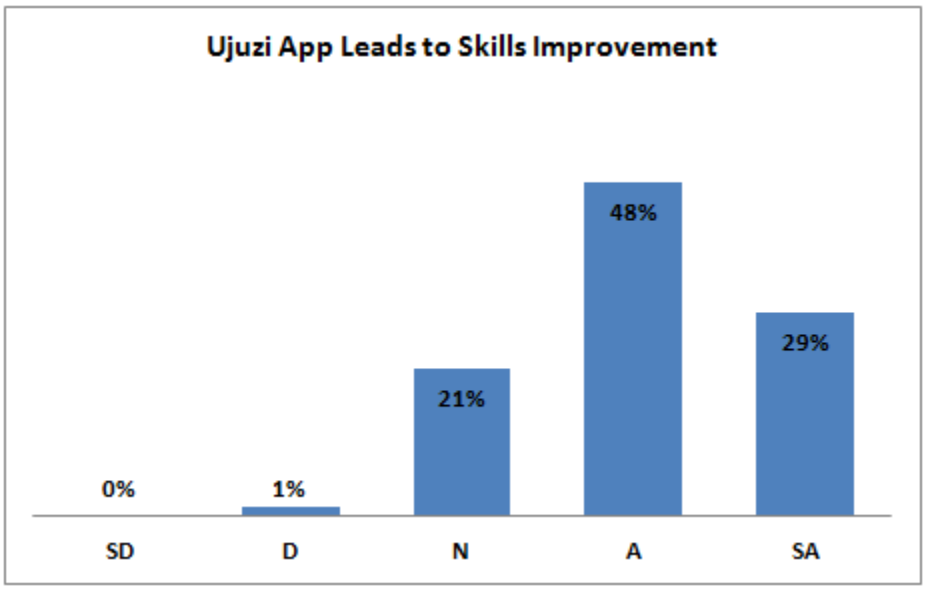

Figure 6-12: Students reaction to Ujuzi app

6.3.6 Areas of Improvements

One key aspect of the democratization processes of technology concerns the involvement of stakeholders during problem development processes as well as post-development stages (Feenberg, 2005). Especially, users of technologies have the opportunity to shape how technologies are used in the same way as technologies shape societies (Allen-Brown & Nichols, 2004; Miller & Costa, 2016). Both students and experts who use the Ujuzi app proposed a number of issues to be modified so as to improve the usability of the application. These improvements are related to application features as well as to the theory behind Ujuzi itself. It is important to note that the suggested improvements do not necessitate re-designing the Ujuzi app. The majority of the suggestions are addressed and the remaining suggestions are expected to be addressed in the, second version of the applications. Basically the essence of using DSR in this work is to ensure the artifacts satisfy the users through multiple evaluations. The following are the critical discussion on the suggested areas of improvement.

First, the Ujuzi app lacks collaboration features. Collaboration features are known to facilitate interaction and communication between learners and issuers (Moore, 1993). Through collaborative features, it is possible for learners to interact with other learners to discuss issues of importance thus to reduce transactional distance (Moore, 1993). Specifically, both students and experts have requested forum features to be added to enable learners to engage in various discussions related to their learning experience. A second matter is the lack of interactivity to the system. The app should offer learners the ability to comment and ask questions to issuers of the content as well as suggest the topics they need to learn. The current situation is that learners are allowed to communicate with the issuers through the Ujuzi brokerage.

Third, the app lacks assessment tools for learners to test their understanding of the content. Also, the identified assessment tools include the analytical tools to monitor the learner's progress. Last is the need to provide in-app processing capabilities instead of relying on the external link as expressed by one of the respondents "*There should be in-app video player to avoid the external links to youtube which send away users from the app*". Other challenges include the registration and authentication need of the app; some learners are uncomfortable and request the feature to be removed so as to make the application as open as possible as reported by one of the respondents "*the app needs the email [address during the registration process], but not all of the students have active email[addresses]*".

The suggested areas of improvements are very supportive of the usability and sustainability of the application. Literature suggests that an individual's decision to use a certain technology is shaped by the belief that such technology is useful and easy to use (Lee et al., 2003). Certainly, by adding users' demands into the application, it improves the usefulness and ease of use. However, not every user-demand must be added into the system before it is used. It is evident that ICT based solutions are in constant change as new discoveries come along as well as business and social and political environmental change. Particularly, the first two suggestions concerning the collaboration and interaction features are relevant and will be added into the second version of the application. However, the third and fourth suggestion contradicts with the underlying framework of being a brokerage application. The role of the brokerage application is to become an intermediary and not a processing (final) application or system. In principle, Ujuzi app is not required for learner's progress as they are carried out by the host application of the provider. Therefore, it is the responsibility of the provider to issue such services for Ujuzi to mediate. The current Ujuzi version is capable of linking the assessment tools from providers to learners. However, in order to include new features into

the system, major modification will be done on the application in all three tiers. For example, the more tables will be added to store data concerning the interactions that take place. In the application layer, the modules that support forums will be needed. Moreover, the front end applications will be expanded to add forms to support the exchange of messages through forums. For example, in each of the available micro-learning content, the form to enable learners to send questions to the issuer will be added. For specific specification concerning the changes, an in-depth analysis will be conducted. However, the modifications will not change the core design of the systems.

The registration and authentication features of the application serve important roles. First, the registration helps to identify both issuers and learners for the purpose of record-keeping and analytics. Second, if the collaboration and interaction features are to be deployed, it is crucial for the communicating parties to identify each other. Third, the authentication of the users helps to control the security and authenticity of the content being shared within the system. Therefore, these features will remain within the application until when justifiable reasons for their removal will appear.

6.3.7 Recommendations from the Respondents

The previous discussions on the limitations of the app focused on the existing setup and functional features of the app. Although are somewhat related, this section focuses on further, future and ambitious expansion. One of the open-ended questions in the survey asked the respondents to share their thoughts and recommendations concerning the Ujuzi app. The responses were analysed and grouped into the following:

- Expansion of the scope: Respondents requested that the Ujuzi app should be expanded to include other education settings such as pre-university levels as well as teachers colleges. Also, the application should be expanded to offer skills to individuals outside the university communities. Moreover, the content and coverage should include all sectors of lives rather than limiting itself within the ICT domain. One of the respondents has this to say: "*I recommend that Ujuzi app not only used in higher learning but also in college and secondary school for the teachers to access the materials they need".*

- Awareness creations; to realize the full potential of the application, more people need to be involved. They include issuers of all kinds and learners. Therefore, it is

recommended that branding and marketing of the Ujuzi app to all potential stakeholders is paramount. Different strategies can be utilized including seminars, advertising and head-hunting of issuers as reflected by one of the respondents "*Marketing the app and training users will help to stimulate usage" (male, 34, 23/03/2019)*

- Leveraging from language opportunity: It is suggested that the current English version should be complemented with other languages especially Kiswahili. The English version is unlikely to attract users (learners and issuers) at pre-university levels as well as those outside the university communities. The availability of a Swahili version will bridge the gap between the haves and the have-nots in the same way the existing mobile and web versions do. Also, the Swahili version will bring the feel of belonging and localization of innovation. One of the respondents provided this feedback "*both languages (English and Kiswahili) should be used in-app so as different people can access*" (female, 32/MU, 23/03/2019).

- Localization of the app: Apart from having a Swahili version, there are a limited number of local issuers. This is due to the fact that micro-learning is new in the institution and is not officially recognized as a learning method. Based on the results, the author is optimistic that as awareness and buy-in processes continue more issuers will join. The involvement of local issuers to share local knowledge and skills through the app will improve usability and attract more users.

- Lastly, respondents were asked to share their reaction based on their experience with the application on whether they can recommend the application to their friends. The results indicate that *hundred per cent* of the experts and *eighty-eight per cent* of students confirmed that the application is useful and they can recommend it to their friends despite the observed areas of improvements as depicted in table1. Figure 6-12 below provides the visual depiction of the responses.

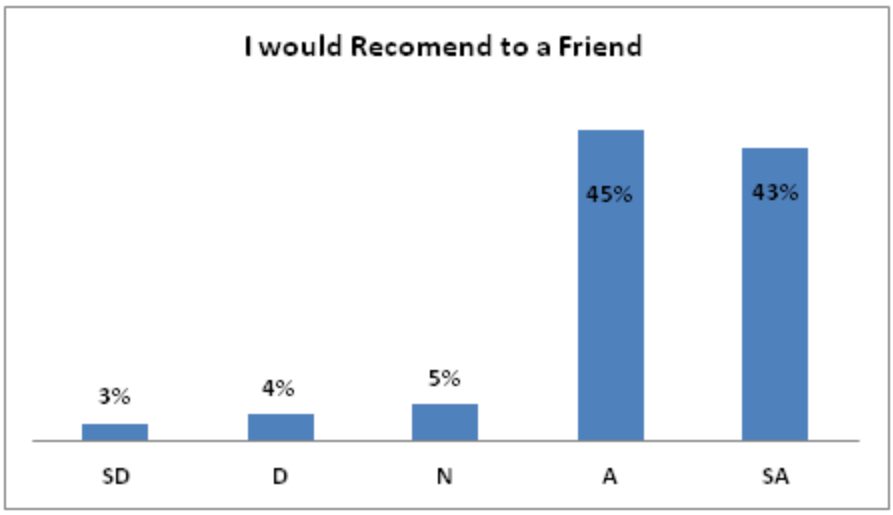

Figure 6-13: Students' Ujuzi App recommendation

6.3.8 Deployment Challenges

One of the primary objectives of this study is to explore challenges associated with the deployment of micro-learning services. As described in the previous sections, brokerage services such as Ujuzi play significant roles in micro-learning deployment. The processes to design, develop and experiment the Ujuzi app at Mzumbe University encountered a number of challenges including the following:

- *Limited awareness* of micro-learning, micro-credentials and digital badges; the preliminary study conducted in the four universities revealed that the majority of the respondents had little knowledge about all of the three concepts (Ghasia, Machumu, et al., 2018b). This impacted the overall conduct of the project from problem identification, design and development of the application. As we discussed in the previous chapters, the decision to apply the prototyping approach was influenced by the lack of well knowledgeable participants who can express their needs effectively to the scholar. Worse enough, the lack of awareness is apparent to students, educators as well as educational technologists, in charge of steering innovations in the universities.

- *Shortage of expertise* in key areas among educators and ICT experts is another challenge: Micro-learning deployment requires a collection of competencies including micro-media, mobile application development, badge designs and deployment as well as instructional design. These skills affect the ability to develop and deploy quality micro-learning contents that are pedagogically and medically relevant to the audience and context to which are deployed. In the qualitative inquiry conducted to ninety-seven respondents, it was realised that all four universities lack an adequate number of

staff capable of carrying out necessary activities. Hence, during the conduct of the project, we relied on the experts from outside the universities to perform some core activities.

- *Attracting issuers* to use the system; micro-learning and micro-credentials rely on the availability of providers of the content. Issuers of micro-learning or micro-credentials can be individuals, organizations, companies, association or institutions with needed experience and capacity to deliver services (Ghasia, Machumu, et al., 2018b). During the implementation of the Ujuzi app at Mzumbe University, it was a challenge to involve lecturers in becoming issuers due to their busy schedule, lack of incentives and skills.

- *Infrastructural challenges*; the situation of the universities in Tanzania can be described as relatively 'immobile', lacking the needed fluidity and connectivity everywhere and every time (Ghasia, De Smet, et al., 2018a). During the implementation of the system, the Mzumbe network was undergoing redesigning which limited access to the Internet. Therefore, the initial plan to utilize the university Moodle server for micro-learning failed due to the lack of access from remote networks; therefore we shifted the micro-learning videos to www.youtube.com instead. Also, the Internet problem is not helped by the fact that not all of the students could afford to pay for mobile Internet subscription for their mobiles.

6.3.9 Limitations of the App

- Lack of integration with providers' applications; the feedback from our participants has raised questions concerning the general processing of the Ujuzi app. To them, the app is supposed to have in-app processing capability that offers both micro-learning and badges rather than relying on the third-party applications. Unfortunately, this limitation is inscribed within the basic concept behind brokerage services, the intermediary and not the processor of the transactions. To address this limitation, the Ujuzi app has to be re-designed conceptually and physically to enable integration with other applications through APIs. The redesigning process needs to include other services including payments and grading modules of which are out of the scope of this version. Future work will have to explore this concern in details.
- Limited scope of implementation; despite the app being developed to fit the higher education sector in Tanzania, the implementation is done at Mzumbe University alone

and by involving fewer courses to avoid bias. Hence, the findings of this experiment cannot be generalized to fit different contexts. We recommend the repeat of these experiments into several other sites including pre-university levels as requested by the participants. Also, further experiments should explore the involvement and implementation of the app outside academic settings to cover employees' professional development and wider communities. One approach is to involve providers and learners outside the university settings.

- Lack of context awareness and AI services; one of the key attributes of mobile technologies comes from context-aware features (Kukulska-Hulme, 2007). Mobiles are able to capture, process and identify contexts based on the locations or attributes of the learners for example, although Mfunzi app at Mzumbe is not AI-based, it manages to provide location-based services to users (Stroeken et al., 2015). The inclusion of context-aware and artificial intelligence features would facilitate context-based brokerage of micro-learning services. Location-based apps are the stepping stone towards aI based apps.
- Ujuzi is an Android-specific application; despite the fact that the extreme majority of students and educators use Androids devices, the need to ensure everyone is able to democratically participate in the learning services is crucial. The current Ujuzi is biased towards those with Android devices. Hence, for the iOS and PC users, the web-version is the only option available to them. For the wider implementation of the app, especially if the bring-your-own-device approach (ByD) applies, the improvement of the app to capture all operating systems should be the focus of future efforts.

6.4 Lessons Learned

The following lessons are learned during the conduct of the project:

- Micro-learning deployment is multi-role and multi-player. It requires commitment from various players including policymakers who are responsible for creating a relevant and enabling environment. In particular, micro-learning and micro-credentials need recognition of employers and academic communities (Abramovich, 2016). The present situation is that the two are not recognized as a valid qualification in Tanzania. With the advances in technological solution and coming of block-chain in education, the deployment of government-based-block-chain credentials will help

to improve trust and sharing of information (Turkanovic, Holbl, Kosic, Hericko, & Kamisalic, 2018).

- Micro-learning deployment is still at its infancy stage. It is yet to be recognized and integrated within the skills development framework in Tanzania. Much is needed to create awareness to the wider communities.
- The need for micro-skills and micro-credentials is high in Tanzania. Based on the qualitative survey that involved ninety-nine respondents and was conducted in four universities, it is clear that students and educators see micro-learning as a solution for the skills gap in Tanzania (Ghasia, Machumu, et al., 2018b).

6.5 Chapter Conclusion

The positioning of brokerage services such as the Ujuzi app in the micro-learning offerings is defined and emphasized in this chapter. Brokerage services are important in bridging the navigation gap between providers of micro-learning and learners. As reflected by the respondents, brokerage services shorten time to access micro-credentials and improve quality content by ensuring providers of the contents are authentic. The Ujuzi deployment at Mzumbe, regardless how small the project is, has shaped our understanding of opportunities, challenges as well as taught us lessons that form a basis for our discussion concerning the deployment model for micro-learning and micro-credential services in chapter seven.

As it is clearly argued, the micro-learning deployment journey in Tanzania is at the infancy stage. The success of the micro-learning and micro-credential projects relies on the commitments from different players including governments, policymakers, education and research institutions, researchers and educators. In particular, it is essential to establish an enabling environment filled with the right skills, infrastructure, policies and support. Micro-learning and micro-credentials requires recognition from employers and policymakers to effectively be used. We sincerely call for researchers, academicians and stakeholders including governments to expand research on micro-skills and micro-learning for the benefit of citizen participation in improving social services.

Finally, in this chapter, it is clearly established that despite the high interest from the stakeholders, micro-learning projects and research are at its infancy stage in Tanzania and beyond. A collective approach to familiarize stakeholders as well as establishing an enabling environment is needed. Specifically, more research to enhance knowledge and practices are needed??

CHAPTER 7

A MICRO-MOBILE LEARNING DEPLOYMENT MODEL FOR TANZANIA HIGHER EDUCATION INSTITUTIONS

7.1 Introduction

The results presented in the earlier chapters reveal the state of micro-learning research and implementations from different parts of the globe. Chapter 4 more particularly presented critical discussions concerning the status of micro-learning implementations in the HEIs in Tanzania. The chapter revealed how optimistic the students and educators are. Likewise, in chapter 5 we explored the challenges that hinder micro-learning access and deployability in the HEIs in Tanzania. Of the presented challenges, the issues related to micro-learning access are explored in chapter 6 through the Ujuzi App implementation at MU. The case not only demonstrates stakeholders' readiness to join micro-learning deployment projects but also puts into the front-row the role of brokerage services in the success of micro-learning implementations. In addition, the case demonstrated how brokerage services can also be used to facilitate digital (open) badges services.

However, as micro-learning research is not yet mature, little is known on how micro-systems and services such as the Ujuzi App can be efficiently implemented in the context of HEIs in Tanzania and beyond. Hence, this chapter presents a proposed model for micro-learning deployment in the HEIs in Tanzania. The model is co-created and co-evaluated together with the educators, students, and technologists to ensure its relevancy. In fact, it is a requirement of the Design Science Research to produce two types of output: the artefact in the form of a product of various forms including the application as well as the knowledge that is communicated through scientific means. Therefore, the model together with the Ujuzi App constitutes the first form of the output produced by this project. This dissertation together with the publications we produced in this study is the second form of output.

The chapter consists of two parts which are logically related as follows. The first part presents factors that influence micro-learning deployment. The identified factors form important components in the proposed model. The factors represent important services and features that contribute to the outcome of the implemented solutions. The second part presents the model that is validated by experts. Specifically, the chapter starts with the introduction in section 7.1 and followed by the background information in section 7.2. In section 7.3 introduces how factors that influence micro-learning success are explored. The

proposed micro-learning deployment model is presented and evaluated in sections 7.5&7.6 respectively. The chapter ends with concluding remarks in section 7.7.

7.2 Background Information

From our explorations, we learned that micro-learning offers various potentials to society including the education sector. In particular, regardless of which deployment approach one applies, HEIs are able to leverage from the highly spreading mobile technologies to impart knowledge and skills to learners anywhere and anytime (Aigerim & Azamat, 2014; Meng & Li, 2016). However, in order to benefit from the emerging learning method, brokerage services and digital badges play significant roles in shaping the interaction between learners and issuers of micro-learning services. In fact, because micro-learning researches are still emerging, there are neither established theories nor deployment models that address the issues of access and trust. Therefore, our proposed model illustrates how to deploy relevant and trusted micro-learning services such as the Ujuzi App in HEIs. Avoidance of privacy breaches and other threats to trust are key challenges but also major opportunities in the context of apps designed for the trusted environment of universities (Stroeken et al., 2015).

In order to develop the model that is relevant to the context, the relevancy cycle of the DSR requires the researcher to explore the environment in which such artefact will be implemented (Hevner 2007). Therefore, the researcher worked with students, educators, education technologists as well as members of management teams to create and validate the model. Through the use of various methods including observation through the Ujuzi case and interviews, the researcher was able to identify and describe key constructs of the model. Also, the author applied information and knowledge from his own published works including Ghasia et al. (2018a) as well as the works of other scholars including Abu-Al-Aish (2014) and (Chambo et al. 2013).

7.3 Factors Influencing Micro-learning Success in HEIs in Tanzania

The results of the literature and the aforementioned efforts identified five categories of factors to influence successful deployment: (i) Reasons for deployments (ii) Technological characteristics (iii) User characteristics (iv) Pedagogical characteristics and (v) Institutional characteristics. Basically, each of the categorical factors contains specific items that are deemed to have an influence on the deployment process as follows:

i. The reason for deployment refers to the purpose and motive behind the deployment. It is argued that the stronger the reasons, the higher the likelihood that the implementation will succeed. In principle, the deployment of any technology or innovation should aim at improving the situation(s), solving a problem(s) and achieving overall organizational goals. Hence, these three factors need to be aligned together.

ii. Technological characteristics refer to how relevant and efficient a given technology is in either solving the intended problem(s) or improving a given situation(s). They include how useful and easy to use such technology is perceived (Lee et al., 2003). For the case of mobile technologies, the affordability and usability of technology are linked to the success of the deployed project (Abu-Al-Aish 2014). It is argued that technologies, which add value to the work and easy to use and are affordable, are likely to be used more than their counterparts (Venkatesh et al. 2003). Also, for mobile-based learning including micro-learning, usability is associated to adaptability and responsiveness of the content; users are easily influenced with contents that are compatible with the capacity and designs of the mobile devices (Kukulska-Hulme 2007).

iii. User characteristics refer to attributes that an individual possesses. They include attitude and innovativeness towards technology as well as the ability to operate and afford given technology (Abu-Al-Aish 2014). Because users are the focus of any technological implementation, having negative perceptions or attitudes towards a given technology will likely resist such technology (Venkatesh et al., 2003).

iv. Pedagogical characteristics include the delivery choices of courses in a curriculum. It is cautioned that, instead of institutions to be influenced by the novelty of technologies, they should ensure that such technology is able to deliver learning as required by the respective course curriculum (Duncan-Howell and Lee 2007; Jaffer, Ng'ambi, and Czerniewicz 2007). The importance of making the right pedagogical choices is presented in chapter 4.

v. Institutional characteristics refer to the ability of an institution to establish an enabling and conducive environment for learning to happen (Bakos & Treacy, 1986). It includes organization culture, infrastructure, policies as well as leadership towards micro-learning. Scholars assert that lack of institutional leadership critically impacts

the performance of any technology-mediated services. In particular, being seen as strong and visionary are crucial in any successful deployment (Macharia and Nyakwende 2010).

In order to establish the relevancy and authenticity of the identified factors in Tanzania's HEIs, an exploratory factor analysis (EFA) was applied to the data. Then, the outcome of the EFA was combined with the interview data to produce the model that fits well with the situation. In the next section, we provide a detailed discussion concerning processes undertaken by the researcher to explore the factors. These processes include testing the suitability of data for EFA and how factors were extracted and evaluated.

As described in our methodology chapter, methods were combined. They include a survey that involved 172 students, 41 lecturers and 19 education technologists from the four universities in Tanzania. On top of that, strategic documents such as policies and student bylaws and websites were studied to identify relevant information related to the study. In addition, in-depth interviews were carried out among 53 students, 30 lecturers, 9 technologists and 8 members of the management team who are in charge of the deployment and oversee the deployments of technology-enhanced learning. The survey and interview guides are attached at the back of this dissertation.

7.4 Data Analysis

Because the present study is exploratory in nature, the exploratory factor analysis approach was applied. The EFA is one type of factor analysis approach that is commonly used for data reduction by organizing related data items into factors based on how they correlate together (Williams & Brown, 2013). Unlike confirmatory factor analysis, during EFA exploration processes, investigators are not guided by theories (Schreiber, Nora, Stage, Barlow, & King, 2006). Likewise, EPA does not involve hypotheses testing, it is purely exploratory. In annexe 7.1, we provide a detailed analysis of how to factor extraction and validation process were carried out.

The outcome of the exploratory factor analysis confirms that the factors that were identified during the literature review are relevant for micro-learning deployment. Indeed, the factors have an influence on the success of micro-learning deployment in HEIs in Tanzania. The table 7-1 below lists the factors and their corresponding items.

CODE	QN	Observed Variable Name
Reasons for deployment (Factor 1)		
RS2	3.1	Imparting specific skills to learners
RS3		Enhancing retention capacity of the learners]
RS4		Complimenting the existing learning approaches
RS5		Improving the quality of learning experiences
RS6		Micro-learning are the true means for learning anywhere, anytime and any-pace
Technological Characteristics		
TE2	3.2	The features of a learning technology should reflect the need of the users
TE3		The deployed technology should be compatible with my devices (mobile/PC)
TE4		The newly deployed technologies should be compatible with the existing media formats (video, text, audio etc)
TE5		Social interactivity with educators or learners is vital for any learning platform
User Characteristics		
US1	3.3	Skilled learners contribute to the positive output
US2		Learners who are capable of paying for services simplifies the transformation process
US5		Poverty affects the willingness to use the learning platforms
Pedagogical characteristics		
PE3	3.4	The pedagogical belief of the lecturers
PE4		The ability of student to relate online learning and learning strategy
PE5		The pedagogical competence of the lecturer
PE6		Digital literacy of the learner
Institutional characteristics		
IN2	3.5	Budget to support technology deployment
IN3		Policies tailored towards wide acceptance and utilization of online learning
IN4		The ability to commit to a vision of implementing and using online learning in learning
IN6		The leaders' competency in technologies

Figure 7-1: Factor list with item names

7.5 Micro-learning Deployment Model

In this section, the discussion on how the model was co-created and co-evaluated by the education stakeholders including learners, educators, and society is presented. The model is intended to explain how relevant and trusted micro-learning services can be deployed in the HEIs. Because our view of micro-learning service delivery exceeds the borders of our studied institutions, some aspects of the model are retained despite broader applicability. Especially, for the issues that involve trust and authentication, recognition, and accreditation of micro-learning services both national and international bodies and agents are recognized by the model.

The items of the factors that were extracted from the EFA were combined with the results of the interviews in order to form the basic constructs of the model. They were subjected to the open coding, axial coding, and focused coding in accordance with the procedures outlined by Corbin and Strauss (1990). The final constructs were analyzed to identify how they associate with each other. Then the model is illustrated in figure 7-1. Also, the coding scheme is attached as annexe 7.2.

Specifically, the model is composed of eight constructs that influence the delivery of relevant as well as trusted micro-learning services. The constructs are

(1) Access issues

(2) Leadership capacity

(3) Learners readiness

(4) Digital Literacy

(5) Institutional preparedness

(6) Attitudes of the learners and educators

(7) Pedagogical choices as well as

(8) Enabling the socio-political environment.

In addition, to ensure trust and recognition, service authentication processes are required as presented in the model. In principle, all the micro-learning services that are offered by the HEIs need to be authenticated by the responsible organs, national or international. While in Tanzania, the TCU and NACTE regulate services in higher education institutions, they are not enough for micro-learning. Therefore, other initiatives such as the Open Badges and Acclaim movements and bodies are included by the model.

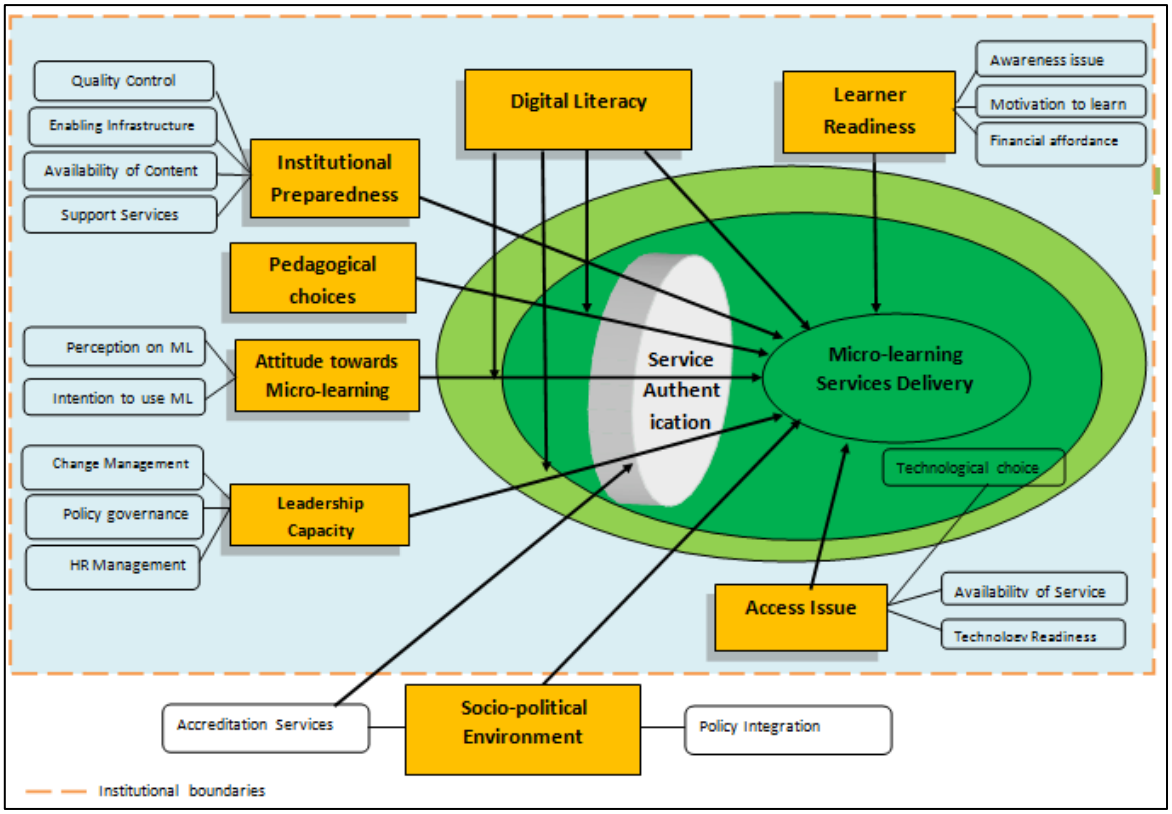

Figure 7-2: Micro-learning deployment model in the HEI

The eight model constructs are described in more detail as follows:-

A. Access Issue

The core of micro-learning success is on the ability to access and learn. In order to achieve that, first, it is crucial to ensure the availability of micro-learning services. It is the responsibility of micro-learning supplies (issuers) to develop and publish micro-learning services in either local or public spaces for authenticated learners to access at their own convenience. Then to facilitate access, such services need to be registered within a brokerage services database for learners to access.

Unfortunately, the results of the study conducted in four universities, as well as the Ujuzi app case, reveal the absence of both micro-learning services and initiatives in the HEIs in Tanzania. The situation is compounded by the absence of qualified micro-learning service providers: individuals, organizations, institutions as well as associations. Surely, responsible stakeholders need to formulate strategies that attract and ensure not only the availability of issuers but also micro-learning services.

Second, it is important to ensure the availability of relevant and suitable technologies to the institution as well as the learners and educators. Micro-learning technologies include

hardware, software, media and platforms for content delivery and access. Since the modular character of micro-learning promotes service availability in various media including smartphones, PCs, and tablets, it is important to devise strategies that ensure learners and educators are equipped with relevant tools. Also, it is important to make the right choices of the technologies to ensure they conform to the acceptable standards. Among key issues to consider when choosing technologies are usability, suitability, affordability, and compatibility.

Also, in chapter 6, we proposed the use of brokerage services in order to foster access to learning resources and interaction between learners and issuers of micro-learning services. As the results indicate, the use of brokerage services shortens time needed and improves access to quality content from authenticated issuers. In addition, brokerage services improve interactions between learners and educators (Anido et al., 2002). Hence, we recommend the deployment of brokerage services so as to facilitate as well as control access to micro-learning services. In particular, only those services accredited by institution, national as well as international bodies are stored in the application.

Also, in order to address technology readiness issues especially regarding the learners, the HEIs as service providers need to apply among the three options:

- to work with the government of Tanzania to expand student loan coverage,
- to offer devices to students,
- to request the government to provide special subsidy to technologies aimed for educational purposes.

The second option helped to succeed in the MoMath project in South Africa (Shao, 2014). When services are offered to the external learners such as remote students, bring your own device ByD approach is recommended.

B. Learners' Readiness

This concerns how ready the learners are to use micro-learning services. Specifically, it deals with the financial affordability for the learners; the ability to pay for required devices, services and Internet connectivity in situations when there is no free and sufficiently fast Internet provided. Likewise, it concerns the awareness of micro-learning services as well as the motives behind the decisions to learn. In order for learners to participate in the learning process regardless of how the technologies were deployed (top-down or bottom-up) depends

on them being ready. Therefore, service providers need to adequately explore the profile of the intended learners before they can deploy services.

C. Institutional Readiness

The institutional readiness construct explains issues related to how ready and prepared are the institutions to accommodate micro-learning services delivery. They include the ability of an institution to offer an enabling infrastructure in the form of the Internet and Wi-Fi services as well as the servers to host micro-learning services. Also, it concerns how prepared the institution is in terms of content development. The two are the basic requirements for micro-learning services to happen at the institution.

Moreover, it examines the existence of reliable quality control as well as support services to ensure that satisfactory levels of services are offered. Especially, learners need to trust the systems that produce the product for them to use it. Therefore, learners need to be aware of the processes undertaken to be assured of quality as well as feel the support of the institutions when the need arises. Specifically, the quality assurance bodies and examinations bodies at all levels need to devise strategies to ensure quality delivery of services. In order to ensure the quality of micro-learning courses and content, we recommend the institutions to form organs comprising experts in the field of micro-learning to validate the content of the course as well as the design of the course before it is offered. Likewise, we recommend that before the content is registered in the brokerage services such as the Ujuzi App, the dedicated team of experts should examine the quality of the content as well as the reputation of the issuers so as to filter-out the inauthentic contents without jeopardizing the open education badges movement. Therefore, we also recommend the contents that are accredited by other quality bodies such as Open Badges.

D. Attitude towards Micro-learning

Another construct is the attitude towards micro-learning concepts and services. Attitudes are shaped by individuals' perception and belief. It is believed that the attitude towards a given technology or innovation influences the decision to use it (Venkatesh et al., 2003). However, the attitude is also said to be shaped by the awareness of a certain technology, if users see a positive outcome from peers who use such technology, they will likely join the project (Rogers, 2002). Hence, we recommend conducting awareness and buy-in efforts to attract learners and educators.

E. Leadership Capacity

The leadership dimension of the proposed model deals with issues related to the strategic management of the deployment projects in the institutions as a whole. It is argued that the attitude and characters of leaders and decision-makers affect the performance of any project (Bakos & Treacy, 1986; Macharia & Nyakwende, 2010). For example in education, it is uncovered that having a vice-chancellor who is ICT literate and innovation-minded influences the uptake of technology-mediated learning (Macharia & Nyakwende, 2010).

i. First, leaders are responsible for policy governance in the institutions. The policy governance attribute of leading concerns with policy formulation and enforcement; because micro-learning is still new, it is essential for leaders to create and enforce policies and institutional commitments towards service delivery. Especially, it is important to upgrade existing policies so as to establish vision and strategic commitments. Specifically, policies should recognize micro-learning as well as micro-credentials and digital badges as a "desirable learning approach" for millennium learners, the two foster life-long and skills-based learning (Buchem & Hamelmann, 2010). For example, policies should lead institutions into recognizing and leveraging from mobiles instead of banning them from educational settings at all levels.

   Likewise, it is important for decision-makers in HEIs to ensure policies are implemented. The current trend shows that available policies are highly under-implemented as required; as a result, there is a high degree of under-utilization of the available platforms (Ghasia, De Smet, Machumu, & Musabila, 2018a; Mtebe & Raphael, 2017). Moreover, the formulated policies at institutional, national and international levels should recognize micro-skills and recruit people with such skills.

ii. Second, leaders and decision-makers are responsible for managing change. Significantly, the successful deployment of micro-learning services depends on the ability of leaders to forecast and manage all necessary change issues. These issues include the ability to provide vision and align deployment efforts to the overall organizational goals. In fact, the lack of goals alignment is the most prominent cause of failure to most of reported IT projects. Also, because changes are linked to resistance, it is vital to predict and manage any occurrences of resistance to change. Some measures to control resistance are to ensure users are involved and aware of the

benefits associated with change. Particularly, building capacities including digital literacy is deemed to be useful as e.g. reflected by one of the respondents that "*digital awareness influences the attitude towards a technology use*".

iii. The third important aspect of leadership constructs concerns human resource management. As it is stated earlier, still micro-learning is at its infancy stage, knowledge pertaining to how to design, deliver and administer is still low in the HEIs in Tanzania. This situation requires institutions to attract and recruit individuals with essential skills. In fact, due to the fast-changing nature of the technological landscape, building capacity to employees becomes a challenge, we recommend the deployment of micro-learning based training to enable employees to learn anywhere, anytime and at their own pace (Buchem & Hamelmann, 2010). Also, strategies to retain skilled employees should be enacted to ensure continuity of services.

Unfortunately, the current trend indicates a high turnover of ICT experts as well as instruction designers in all the HEIs. The same is witnessed during our fieldwork as some experts we had interviewed at the start of the study had already moved to another organization during the next visit to the same institutions including the OUT. The issue of staff turnover is also reported by some local scholars including (Mtebe & Raphael, 2017). We argue that failure to empower and retain skilled employees will cause the deployment project likely to fail due to distractions.

F. Pedagogical Choices

The literature reveals that the success of any technology-mediated learning depends on the integration of pedagogical values within technologies and educators (Duncan-Howell & Lee, 2007; Jaffer et al., 2007). Similarly, the respondents indicated that the pedagogical belief of the lecturer is one of the factors that constitute micro-learning deployment success. They both suggest that the course delivery approaches are important for micro-learning to succeed. In particular, micro-learning contents and activities can be blended with other learning approaches including traditional face-to-face, or they can be delivered as a separate and complete distance-based course (Polasek & Javorcik, 2019). However, each of the available choices not only affects the way content and activities are scheduled but also ways learners are administered and handled. For example, if micro-learning services will be blended with traditional face-to-face approaches, learners will be forced to attend both online and physical class sessions. However, if it is offered as a distance course, learners will need well-

formulated communication channels and support so as to avoid transactional-distance between them and institutions, educators as well as colleagues (Brown, 2005; Moore, 1993).

G. Digital Literacy

Also, digital literacy is as important as other factors that foster micro-learning deployment in any environment. Digital literacy is referred to as awareness, competency, behaviour, and attitude towards the application of digital tools to realize socio-economical responsibilities (Pade-Khene, 2018). In particular, digital literacy is associated with the empowerment of individuals from carrying out their lives. It includes the ability to operate digital devices, media, and tools as well as the ability to access and participate in online services. In the current work, we see digital literacy having an influence over other constructs. For example, digital literacy influences leadership decisions. In fact, leaders who have ICT knowledge tend to come out better when it comes to making decisions that involve technology. Also, digital literacy impacts the attitude of the learners and students as indicated in the model.

However, digital literacy is limited in low-income countries including Tanzania. The majority of students wait until when they join HEIs to acquire digital awareness and skills (Ghasia, De Smet, et al., 2018; Nagunwa & Lwoga, 2012). Moreover, the majority of the Tanzanians fail to join universities due to a number of reasons beyond the scope of this work. In this kind of environment, if the situation is not remediated it is unlikely that micro-learning projects will succeed. We recommend that digital awareness and skills be given to individuals at the institutional and national levels to empower and boost their participation in technology-mediated learning including micro-learning, hence to reduce the digital divide. In order to impact widely, digital and ICT skills should be integrated and implemented starting from low education levels. Unfortunately, rather than recognizing the benefits of providing digital skills to students so as to foster best practices, the decision-makers resort still in banning mobiles in pre-university levels (EATV, 2018).

H. Enabling Socio-Political Environment

This chapter emphasized the importance of approaching deployment projects coherently, by involving multiple stakeholders. While all of the aforementioned constructs relate to the institutional capacity, this dimension's parameters fall beyond the institutional mandate. Specifically, we assume that micro-learning deployment projects are complex and socio-political in such a way that they require multiple interventions. Our arguments are shaped by

the belief that in order for micro-learning to achieve satisfactory results, the following need to be addressed.

i. The micro-learning approach and associated concepts such as micro-learning and digital badges need to be identified and recognized by the responsible national and international organs (Ghasia et al. 2018b). Particularly, employers and educators need to be able to recruit and enrol individuals identified to have micro-skills acquired through the micro-learning approach provided that they can demonstrate such skills. Also, just like other learning approaches, national and institutional bodies should establish a mechanism to evaluate and accredit credible micro-learning courses as well as recognize issuers of those courses. Likewise, national bodies should explore the new methods of assessing, authenticating and recognizing learners' achievements including micro-credentials and digital badges (Ghasia et al. 2018b). We state that the existence of frameworks recognizing micro-learning and micro-credentials will create the needed interest from individuals and society as a whole.

ii. Similarly, coordinating deployment efforts at the level of policy integration is required. It is reported that amongst challenges which hinder deployment of technology-mediated learning include electricity shortage, the high price of ICT technologies as well as Internet connectivity. The mandate to address the challenges of this nature falls beyond the institutional capacity; hence, there is a need for an integrated approach when dealing with micro-learning deployment projects. For example, in order to support institutions which are deploying micro-learning services, the government should address issues related to electricity, loans to students, cellular network coverage as well as subsidizing on technologies related to education.

iii. Also, In order for community-based learning to flourish, we recommend the establishment of a 'learning culture' which sees learning as part of individuals' lives. We argue that it is the existence of a learning culture that would make individuals and societies see the value of devoting time and resources for the acquisition of knowledge and skills.

7.6 Evaluation of the Model

Basically, it is recommended to validate a model after it is developed in order to establish its suitability and usefulness. Likewise, it is one of the principal requirements of the DSR to

validate artefacts to establish its efficacy in solving or improving social problems. In fact, the validation of the model helps to identify its relevance and reliability in achieving the intended objective (Qureshi, Harrison, & Wegener, 1999). As the key aspects validated we point to the fit to the intended task, the completeness as well as the flexibility of the model to adapt to the changing environments and variables (Ling & Leng, 2018).

In principle, there are two categories of validation approaches: quantitative and qualitative. Commonly, models are evaluated quantitatively by using statistical methods that apply either inferential or descriptive statistics (Qureshi et al., 1999). Likewise, models are evaluated by using qualitative methods that involve individuals or experts (Bennett, Croke, Jakeman, Newham, & Norton, 2010; Ling & Leng, 2018). Technically, because there are no perfect methods since each method encompasses some weak spots, it is recommended whenever possible to apply a combination of methods. For example, a model can be validated by using statistical methods before and then followed with qualitative methods and compare results (Qureshi et al., 1999).

The qualitative validation techniques rely on human informants in the form of interviews, observation, or questionnaire. The commonly used technique involves face validation also known as "expert's opinion" (Ling & Leng, 2018). The expert validation can either be peer debriefing by involving external members or member checking that depend on the people involved during data collections. According to (Creswell, 1998), member checking is important not only because it helps to confirm the findings, but also to validate the formulated model. Also, qualitative approaches are used because they are convenient, time-saving as well as minimizing costs (Bennett et al., 2010). It is also a preferred option in situations when there are limited statistical data available for evaluation.

In this study, given the infancy of the micro-learning research and initiatives, it is evident that data regarding micro-learning deployment projects are few. Therefore, a qualitative approach, especially member checking and expert opinions were applied. We adopted the validation guide from (Ling & Leng, 2018). The questions were used as they are sent to the experts through the use of Google Forms. The advantages of using Google Forms are presented in chapter six. In addition, emails were sent to experts to request them to fill the forms. The experts were purposefully selected based on their participation in technology-mediated learning or information technology deployment. Other criteria were being scholar, educator as well as educational technologists. Exactly, five of the experts who most have over ten years of experiment in the area of technology-mediated learning evaluated the model and

indicated their satisfaction. Apart from little modification, the model is evaluated as correct, flexible as well as suitable to address the intended objectives. Particularly, the experts suggested three issues:

i. To rename the "Availability of content" to "Content development";
ii. To move the renamed item from pedagogical choices construct to "institutional readiness". The item was moved as suggested without changing the name as the current name fits well with the destination construct.
iii. To rename the "Access issue" to "Technological readiness". The suggestion was not implemented because access issues cover issues more than just technology including the availability of micro-learning courses.

Hence, a model presented above reflects the opinions of the experts. The evaluation guide is attached as annexe 7.2. Because of the subjectivity associated with the qualitative approaches, these results may not be generalized, therefore the future work will be to evaluate the model based on the real data from the real micro-learning environment.

7.7 Chapter Conclusion

In this chapter, the model to foster relevant and trusted micro-learning service delivery is presented to complement the Ujuzi App artefact presented in chapter 6. Just as the Ujuzi App demonstrated how brokerage services are able to address the access and navigation challenges associated with the micro-learning architecture, the deployment model addresses the remaining challenges related to how the services need to be implemented in the HEIs. Together with the model, the descriptions of the processes undertaken by the researcher to construct and validate the model are outlined.

Just to summarise, the model is co-created and co-validated by involving students, educators, and educational technologists through interviews and surveys. Also, to check the validity of the model, the "member checking" and "experts' opinion" approaches were used by involving prominent scholars and educators in the area of technology-mediated learning, especially in the African context. Although member checking and experts' opinion is perceived to be subjective, just like other qualitative methods, they are highly regarded at providing reach and in-depth explanation about the phenomenon, they are especially good in the situations when the phenomenon is new and members of the society are not fully conversant with the situation just like the Ujuzi case (Boellstorff, 2012).

Basically, the model is informative to the decision-makers and policy-makers who either intend to enhance micro-learning deployment as well as knowledge. Likewise, the model sheds light on key interactions needed to happen for the micro-learning to succeed. Future works need to examine in detail the practicality of the model in a real-life situation. It outlines key issues that influence micro-learning service delivery. Importantly, it stresses the need to set strategies that inspire learners' confidence and trust of micro-learning services. The bottom line is that institutions should be well prepared with all necessary policies, infrastructure, leadership, and adequate competencies. Also, through the use of institutional, national and international bodies, it is required to establish a mechanism to accredit and recognize micro-learning courses, contents as well as skills acquired through them. In particular, the recognition of micro-credentials such as digital badges and integrating them within the micro-learning ecosystem will facilitate the expansion of the HEIs' mandate beyond its borders.

As we conclude, it is now apparent that the development of both the Ujuzi App and the Model constitutes a positive intervention towards the micro-learning approach. The need for brokerage services such as the Ujuzi app in enhancing learners' access to micro-learning services is unquestionable as it shortens access time as well as controlling the quality of the content. However, such services will unlikely to achieve the intended objectives if they are not correctly deployed. Therefore, we need the proposed model to shape deployment processes and activities.

CHAPTER 8

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

8.1 Introduction

This chapter concludes the four-year research on *Supporting Micro-learning Access through the Ujuzi Mobile App: A Brokerage Deployment Model and Pilot Study for Tanzanian Higher Education Institutions.* Especially, during the research period, the researcher together with the educational stakeholders from the four universities in Tanzania: the UDSM, UDOM, OUT, and MU co-created and co-evaluated the artefacts and the findings of this study. Through the application of the Design Science Research Approach, the Connectivism Learning Theory, and the Critical Theory of Technology, it was possible to not only explore the situation and identify challenges associated with micro-learning access and deployability in the HEIs in Tanzania but also to devise solutions. The Ujuzi app implementation case at Mzumbe has improved the knowledge concerning micro-learning access; it is evident that the introduction of brokerage services improves the quality of micro-learning access. Likewise, through the application of the model proposed in chapter 7, the education stakeholders, institutions and policymakers are well-positioned to make an informed decision concerning micro-learning deployments in their respective contexts.

Therefore, in this chapter, we reflect on the research processes, decisions made and methodology and methods that lead to the outcomes of the work. In addition, the chapter presents the discussions of the key results, recommendations, study limitations as well as suggesting future areas of research.

In order to simplify the process of navigating and digesting the content, the chapter is organized as follows: Section 8.1 introduces the chapter. Then the background information is provided in section 8.2. Next, in section 8.3 we present general discussions of the results and recommendations to be considered by the education stakeholders, researchers as well as policy-makers. Also, the implications and limitations of the study are presented in section 8.4 and 8.5 respectively. Then section 8.6 presents the suggestions for further studies.

8.2 Background Information on the Study

At the beginning of our dissertation, we clarified that micro-learning research is prompted by the high proliferation of mobile technologies. As long as it is acceptable that people and technologies change and impact each other, there is no doubt that the ubiquitous devices are transforming the way we conduct our lives. In education, micro-learning has become a new

area of research for over a decade. In chapter 2, we have indicated theoretical gaps concerning micro-learning access, trust, and deployability, particularly in the higher education context. Specifically, we explained how the design and publishing of micro-learning units on the public Internet impacts the ability of the learners to access and manage micro-learning content from various providers. Likewise, we indicated how risky and problematic it is for the inexperienced learners to navigate and decide on the online content. In addition, we explained how the lack of theories and models concerning micro-learning deployments hinders the HEIs from making the right choices and decisions. Informed by the gaps, the current study engaged in enhancing micro-learning access and deployability in the HEIs in Tanzania.

Prompted by our commitment to intervene in the situation technologically and theoretically, the Design Science Research (DSR) proved to be the ideal philosophy for the study. Apart from developing or justifying theories, the DSR focuses on solving social problems through the production of artefacts in terms of a construct, a model, a method and an instantiation. Likewise, the Design Science, demands the production of artefacts that are relevant and rigour to the environment as well as to the wider community. Also, in the application of the Critical Theory of Technology (CTT), the philosophy of technology puts more emphasis on the involvement of the people in the production of artefacts. Specifically, we concur with the CTT that technology is neither neutral nor autonomous and the democratic nature and need of the designing processes need to be observed carefully. In addition, in order to ensure the artefacts to reflect the educational needs of the millennium learners, we relied on Connectivism, the learning theory of the digital age.

The application of the three theories helped to position our study in a specific environment and to involve the education stakeholders in the production of artefacts. Specifically, in this work, the context is the HEIs in Tanzania. Hence, through the application of the DSR methodology, the stakeholders were involved during the relevancy cycle to explore the status of micro-learning and micro-credentials application in the HEIs, during the design cycle to provide design specifications and preferences, as well as to evaluate the efficacy of the Ujuzi app and the deployment model as detailed in chapters 4-7. Specifically, both the qualitative and quantitative data collection and analysis methods were used with success in the exploration of the environment as well as during validation of the artefacts.

8.3 Discussions about the Results and Recommendations

Despite the fact that micro-learning research is still at the infancy stage, the results produced in this study expand the understanding of micro-learning, especially in the area of access and deployment. Not only has the study managed to increase our knowledge of micro-learning in higher education in Tanzania, but also the correct application of the artefacts, as well as recommendations, will likely improve the application of micro-learning methods in education settings. In this section we provide a general discussion of the key findings and recommendations of the study as follows:

8.3.1 The State of Micro-learning in the HEIs in Tanzania

In chapter 4 we presented a detailed account of the HEIs in Tanzania concerning not only micro-learning but also micro-credentials application. Specifically, we presented the situation concerning the awareness, perception, and attitudes of the stakeholders including the educators and students. Moreover, the state of the institutional preparedness and readiness with respect to micro-learning and micro-credentials were critically discussed. Basically, the exploration of the environment, as required by the relevancy cycle of the Design Science, provided the researchers with relevant specifications of the problems associated with micro-learning access and deployment. In particular, the situation at the institutions justified the need to conduct further studies to address the access and deployment gap in the forms of the Ujuzi App and the Model as presented in chapters 6 and 7 respectively.

8.3.1.1 Stakeholders Awareness of the Micro-learning and Micro-credentials

The awareness and knowledge about micro-learning and micro-credentials are essential in improving micro-learning access and application in education and beyond. The results suggest the need to explore the top-down model for technological interventions in the educational settings and let the digital natives to lead the way in a bottom-up strategy. Specifically, the majority of the students (65%) and education technologists (79%) are aware of micro-learning and their associated concepts. On the contrary, only 40% of educators are aware of the same. Also, the results from the qualitative interview reveal both micro-credentials and digital badges are the new concepts in such a way that very few of the respondents had a clear understanding of how they relate to education.

8.3.1.2 Experience with Micro-learning

Regrettably, the overall experience of the respondents with respect to micro-learning as well as micro-credential services is very low. In fact, only 42% of the technologists, 25% of the

lecturers and 9 % of the students have experience with micro-learning. Also, the HEIs in Tanzania are yet to deploy or integrate either micro-learning or digital badges in their educational systems. The lack of micro-learning and micro-credential activities is confirmed by 74% of the education technologist, 65% of students and 67% of lecturers who indicate there are no micro-learning services in their universities. Surely, there is a need to devise strategies to implement micro-learning services for the students as well as the community.

8.3.1.3 Accessibility of Micro-learning Services

The importance of the ability of the learners to access content from anywhere and anytime cannot be overemphasized. Especially, learners need to access micro-learning content from various providers with ease and confidence. While the ease of accessing the content to some extent is facilitated by the quality of the Internet services, other factors including the architecture of the micro-learning applications and content play a significant part. In chapter 6 we have indicated why the use of brokerage services is essential to address the access challenges. Likewise, we have demonstrated how the integration of digital badges and other accreditation and quality control services improve the quality of content accessible to the brokerage service users.

8.3.1.4 Stakeholders attitude towards micro-learning

Despite the availability of challenges as well as the limited awareness of micro-learning and micro-credentials, the overwhelming majority of the students and educators in all the universities are optimistic about the two concepts as detailed in chapter 4. Especially, the use of digital badges seemed to draw a higher interest from the students. In fact, students are attracted by the possibility that their skills and achievements will be formally recognized. Moreover, both students and educators believe that digital badges will improve the quality of learning as well as skills development.

8.3.2 Challenges to Micro-learning Success in the HEIs

The second objective of the study was to explore challenges that hinder micro-learning success in the higher education institutions in Tanzania. In particular, it is required by the DSR to study the phenomena facing the environment before devising the mechanisms to improve the situations to ensure relevancy. As discussed in chapter 6, there are a number of challenges that hinder micro-learning as well as micro-credentials success in HEIs. Among the key challenges are the inadequate infrastructure, the lack of digital literacy and competencies, as well as the challenges related to change management. In addition, there is a

marked absence of policy commitments tailored towards micro-learning and digital badges at the institutional and national levels.

In fact, the absence of reliable and quality infrastructure such as the Internet across the institutions and the country to support micro-learning activities limits the implementation of the Connectivism philosophy of learning that perceives learning as a network forming process. It limits access to learning resources as well as blocks communication, interaction and collaborations between learners and educators.

Likewise, as the chapter stresses, limitations associated with digital awareness and skills among the learners and educators limit learners and educators from leveraging from the publicly available micro-learning services. As it is stressed in chapter 6, it is frustrating and risky for the digitally illiterate learners to traverse the Internet spaces, full of diverse contents on various topics and quality including the 'fake news and contents'. Likewise, digital literacy is needed by educators to design and deliver desirable and suitable micro-learning content to the intended learners across the globe. With the absence of trust and technological solutions to the problem, the researcher turned to the concept of brokerage services in order to address the challenge as discussed in chapter 6.

Moreover, the absence of policy directions and commitments impacts micro-learning success. As it is discussed in chapter 5, neither the HEIs nor the Tanzania education system recognizes micro-learning and micro-credentials as a legitimate learning and authentication methods. Consequently, skills acquired through micro-learning including digital badges are not recognized by the employers at all levels. Hence, the application of micro-learning in the HEIs is left to the individual lecturers and students to try at their own leisure. We argue that, unless micro-learning methods, skills, and digital badges are recognized, the chance for success is limited.

In addition, the micro-learning success is hampered by the lack of directions or framework directing how the changes need to be addressed. Especially, due to the limited awareness about the efficacy of the micro-learning methods as well as services, decision-makers are nervous about the consequences of adopting the new project. The presence of the model informs and prepares stakeholders on key issues to implement for the successful output. To address these challenges, the scholar explored the environment and produced the deployment model presented in chapter 7. If well implemented, the model will address issues related to attitude, resistance to change as well as motivation to use the micro-learning services.

8.3.3 The Role of Brokerage Services in the Micro-learning Success

Exploring the role of brokerage services in improving micro-learning access was the third objective of the study. As required by the Design Science Research to produce artefacts that solve the identified relevant social problems, this study explored the role of brokerage services in addressing challenges related to the access of micro-learning services posed by the architecture of the micro-learning services access. In collaboration with the stakeholders, we co-designed, co-developed and co-evaluated the Ujuzi App–brokerage service. The app was evaluated by the stakeholders to identify its efficacy in addressing the intended problems. Especially, as a brokerage service, we wanted to examine its role in addressing the identified challenges.

As the result suggests, if correctly applied, brokerage services such as the Ujuzi app are capable of significantly improving the micro-learning services. Particularly, micro-learning brokerage services are the intermediary applications that fulfil two responsibilities. First, they mediate communication and interactions between the learners and issuers of micro-learning and micro-credential services in the form of service exchange; the learners receive learning content and services in exchange for money or recognition. Second, if well implemented, brokerage services help to control the quality of the content. Unlike the public Internet that is open to everyone, brokerage services ensure that only authenticated issuers are allowed to publish through the systems. Hence, as attributed by the respondents in chapter 6, brokerage services are thought to shorten the time needed to search for content, as well as lead to quality content and improves skills among other benefits.

8.3.4 Micro-learning Services Deployability in the HEIs

The fourth objective of the study was to develop a micro-learning deployment model to explain and facilitate the delivery of micro-learning services such as the Ujuzi App. the motive to develop the model was prompted by the lack of literature and theory towards micro-learning deployment in HEIs, especially in Africa. Also, it was necessary to address the challenges related to micro-learning service delivery in the HEIs as uncovered during the situation analysis. Specifically, we wanted not only to explain the constructs or factors necessary for micro-learning success but also to explain how they interact relate to each other.

In chapter 7 we presented the second artefact of the study, the model for micro-learning delivery in HEIs. Specifically, we have identified the eight key constructs that need to be

addressed for micro-learning and digital badges to happen and be sustainable. As discussed, it is the composition of strong leadership, learners' readiness, institutional preparedness, availability of an enabling socio-political environment, digital literacy as well as attitudes of the learners and educators. In addition, success depends on the pedagogical choices and provision of quality strategies that ensure availability and access to micro-learning services.

In the chapter, the explanation of each of the constructs is provided. Also, the model suggests the existence of interactions between constructs. For example, it is theorized that the digital literacy impacts the attitude to engage in micro-learning activities, the ability of the leaders to manage the micro-learning projects, as well as the delivery of micro-learning services. Also, as the model suggests, the establishment of trust of service relies on the existence of external actors an the national and international levels. For example, the identification, recognition, and accreditation of micro-learning services and skills can be done by the quality-guarding bodies at the institution in collaboration of other organs such as the TCU and NACTE at national level as well as other bodies that recognize digital badges, e.g. the Open Badge movement headed by the Mozilla foundation.

As required by the DSR the model was positively evaluated by the experts. However, the success of micro-learning does not end with the model but the ability to translate and implement it correctly. In the next section, we present the recommendations associated with the application of the model for the policy-makers as well as educators to apply and expand their scope. Also, as we explained in the associated chapter, the practical evaluation of the model is needed to examine its efficacy in real-life situations.

8.4 **Recommendations for the Study**

Having managed to study the phenomena and produce the artefacts that are positively evaluated by the stakeholders, we see ourselves in a position to make some recommendations necessary to improve micro-learning implementation in HEIs as well the micro-learning research in general. The recommendations outlined in this section reflect and are in line with the recommendations we presented in the respective chapters. While we are not claiming that the outlined recommendations can be likened to holy scripts, they can be translated in accordance with the prevailing situations at the respective institutions as well as by the concerned individuals.

i. Establish a Digital and Learning Culture within and beyond the Institutions.

It is important to device the mechanism to impart digital and learning culture to students and educators. Specifically, learning should not be restricted to formal learning in class. We argue that the culture should start at lower level education like at least secondary education. Likewise, the use of digital media should be made a habit and not an obligation. Through training and awareness campaigns it is possible to improve the situation.

ii. Spread Knowledge and Awareness about Micro-credentials and Micro-learning

Because they are new concepts, we recommend that responsible organs, as well as institutions, should ensure that stakeholders are theoretically and practically aware of the digital badges and micro-learning potentials. The awareness of the opportunities will likely inspire usage and improvements.

iii. Establish an Enabling and Conducive Infrastructure

Specifically, we recommend that the quality of the Internet and Wi-Fi services should be improved. Also, the network coverage in the country should be expanded. The 4G connectivity should not end in a few town centres as it is now. More communities including those in remote areas need to be served with quality services.

iv. Policy Integration and Enforcement are the key to Micro-learning Success

There is a high need to ensure not only policies are formulated and enforced but also are integrated together. For example, the digitization policies should go hand in hand with the improvement of social services such as access to electricity and clean water to ensure learners are not distracted. Likewise, policies related to the ICT deployment in education should be linked to imparting digital skills to teachers as well as subsidizing technologies so as to ensure ownership to the majority.

v. Establish Strategies to Support Learners and Educators

Technically both local and distance learners and educators should be supported in case of any technical problem. There should be ready standby services to provide support user with respect to content access and use. Also, other forms of support should be accessible whenever possible. We recommend the establishment of online support systems including websites, webchat, and questions and answer sessions to clarify all important

and common issues. Likewise, specialized support to people with special needs is advised.

vi. Establish a Mechanism to Monitor and Control Quality of Micro-learning Services

In order to ensure the sustainability of quality services, we recommend the establishment of quality checks within the institutions. Before micro-learning courses or contents are published online or registered in the brokerage services, their qualities must be checked. Also, there is a need for responsible organs to establish acceptable quality standards for micro-learning services. The standards will guide the creation of the courses, the content as well as accreditation of micro-learning services. For example, if a new provider of micro-learning courses wants to be registered, agreed and published quality standards will guide how to evaluate their services.

vii. Improve and Expand Students Loans

Student loan grants have proven to be the main source of device ownership and service access. Students use the loan provided to not only solve the intended use but also to buy computers and mobile phones. We have witnessed the outcry for increasing student loans. Also, the majority of the students are not supported. We recommend that if possible all of the students applying should be supported and students should be encouraged to apply.

viii. Deploy or Join Brokerage Services

As it is demonstrated in chapter 6, brokerage services will improve the quality of micro-learning service deliveries. We recommend the provider of micro-learning services to establish brokerage services or join the existing services in order to leverage from micro-learning.

ix. Evaluate and Implement a Micro-learning Deployment model

The model presented in chapter 7 is still new. While we are satisfied that it explains the context to which it was developed, we recommend that the model be further evaluated in different contexts. We also encourage the responsible organs, institutions or individuals to adopt and implement the model constructs in different contexts. In the end, the model needs to be updated and improved accordingly.

8.5 Contribution of the Study

At this juncture, we are proud to declare that the study has managed to achieve its intended objectives to a good degree. Through the use of the identified theories and together with the respondents and my supervisors we have managed to contribute not only to the theory concerning micro-learning but also by offering practical artefacts that can be used to improve the situations. The following are the key contributions realized from this study:

8.5.1 Theoretical Contribution

First, the study has managed to contribute knowledge and understanding of the status of micro-learning implementation in higher education institutions, more specifically about Africa and Tanzania. As we have indicated before, there is scarce literature concerning micro-learning, especially on the Africa continent. This work is among the first few full studies devoted to the topic. Therefore, our findings establish the basis for further studies to build upon. In our work, we have indicated the perception, attitude, awareness, and readiness of the education stakeholders such as students, educators and education technologists towards micro-learning. These findings and setups are important to the micro-learning studies of Africa and beyond.

Second, in chapter two, we have presented our analysis of the state of literature concerning micro-learning and micro-credentials as well as digital badges by combining scholarly works from across the globe. Within the analysis, we have exposed the state of micro-learning research as well as exposing the gaps to be filled. Our report will help other researchers in their future work especially to fill the gaps that we did not address.

Third, we have improved knowledge concerning micro-learning architecture and access. During the literature review, we identified the gap related to the micro-learning access attributed to the architecture. We explained that the use of micro-learning units contributes to the challenges associated with access. We indicated that it is frustrating, confusing and risky for inexperienced learners. Due to that, we have demonstrated how the use of brokerage services will help to address the challenges. This is the first time that brokerage services are used to study micro-learning access issues in Tanzania. It is our hope that other scholars will build from our work to explore further.

Fourth, we have improved knowledge concerning trust and quality control. In chapter 2, we identified the gap related to the lack of mechanism to ensure access to quality resources. We explained that it is risky for inexperienced learners due to the fact that some contents on the

Internet are of low quality. Through the use of brokerage services, we have demonstrated how brokerage services can be used to filter out unwanted content.

Fifth, we have contributed a model for micro-learning deployment in higher education institutions. Likewise, this might be the first model of its kind concerning micro-learning deployment in higher education institutions. Nevertheless, the model is yet to gain a needed confidence level as it is still new. It is safe to claim that the constructs and the interactions outlined in the model will be useful in future research.

8.5.2 Practical Contributions

First, our work has hopefully opened awareness of micro-learning, micro-credentials and digital badges to the communities of the four universities we worked with. During the data collection, results sharing and workshop at UDOM, we have managed to introduce the concepts to quite many individuals. It is likely that the awareness will create a higher readiness to apply them.

Second, the model we have produced is accessible to the general public. Both policymakers and decision-makers are in the position to understand the key concepts to apply before deploying micro-learning services.

Third, apart from the findings that can be used by the general communities, we have shared recommendations to be addressed by various stakeholders in their pursuit of micro-learning services.

Fourth, we have established a new area of research and community engagement. The Ujuzi App used to explore the potential of brokerage services will not be discarded. Upon the completion of this work, the app will be improved and implemented at Mzumbe University for the sake of imparting skills to students and the wider community. If it succeeds, there is a possibility to support and impart skills to various other community groups including farmers.

8.6 Limitations of the Study

i. Limited Scope and Coverage

As described in the preceding chapters, this work was conducted in just four universities in Tanzania and by involving a small fraction of the population. Also, all four universities are public universities. Although the numbers and methods used justify the results, it would be better if the scope and coverage would be expanded so as to make the work outcome more

generalizable. However, due to the fact that micro-learning research is new, we don't believe that the addition of the sample would change the results obtained.

ii. Limited Micro-learning Experience

Again, because the research area is new, we had very few experts in the field. Also, we lacked a practical site to explore based on the actual data. Also, there are a limited number of scholarly materials on the subject. The lack of materials is worse when one considers the African region. It is our hope that, with the increasing interest in micro-learning, we believe that this problem will prove to be temporary.

iii. Limited Application of both the Ujuzi app and the Model

While the limitations associated with the Ujuzi App are outlined in chapter 6, the bottom line is that the two artefacts need more time and application in a wider range of sites with varying conditions to evaluate their performances.

iv. Limited Involvement of Managers at national Levels

The design of the study was limited at the institutional level. While this commitment was realized, I see the need to involve policy-makers at the ministerial levels in future work. The first entry point will be by sharing the findings of this work which the author intends to do.

8.7 **Suggestions for Further Research**

While we hope that the work we have done during the conduct of the study, including the production of this dissertation and other publications including workshops and posters presentations, will be appreciated, it will be unthinkable to claim that we have exhausted all the information and knowledge concerning micro-learning. Also, the reality that the research on micro-learning is still growing, we stress that much needs to be done to improve knowledge of the emerging learning approaches in terms of their efficacy, theory and practical application in the society. Specifically, we suggest the following areas of research:

i. Context-based Micro-learning Solutions

One of the affordances of mobile devices is the ability to identify and provide context-based data such as location and the profile of the users. We support the call to utilize the context-based features into educational based technologies. With the advances in the area of artificial intelligence (AI), we believe that it is possible to embed intelligent systems into the micro-

learning ecosystem so that micro-learning content will be automatically assembled or suggested in accordance with the contextual details of the learner. For example, if the prospective learner has certain disabilities or preferences, then the content should reflect the same.

ii. Application of the Micro-learning Model

The model produced in this study is still new, it has never been tested anywhere. Just like any other model, the validation details are not enough to guarantee its efficacy elsewhere. We recommend that further researchers should apply the model, as a whole or its constructs, to examine its usefulness in real-life experiences. Likewise, the model was evaluated by using experts' opinions rather than statistical methods. We suggest that further study studies attempt to apply relevant quantitative or mixed methods in order to evaluate the performance of the model.

iii. Expand the Research Coverage

As it was indicated, this dissertation reports on the work conducted in just four public universities in Tanzania. We suggest further studies be conducted to include more universities, including privately owned, however, we do not expect any changes to model because the situations are similar to that of public universities. Likewise, we concur with our respondents' suggestion, the study on micro-credentials and micro-learning should also focus on pre-university levels of education as well as teachers' colleges. We also recommend the research on micro-learning to be directed to the communities outside universities to cover informal learning settings.

iv. Implementation of the Ujuzi App

We have demonstrated the application of brokerage services in education, especially in the area of micro-learning. The success realized with our single site experimentation gives us the impetus to suggest the same research be expanded in a wider community and by using more data sets. Also, we recommend the integration of micro-credentials in the form of digital badges in the micro-credential implementation. The current experience is that the two movements are separate; we suggest that future micro-learning deployment should integrate digital badges as a compulsory function in such a way that upon completion of micro-learning courses, digital badges should automatically be awarded. Currently, such services are not at all available especially in the HEIs in Tanzania,

With the aim of successful integration, research on the performance, acceptance, and effects should be conducted for the sake of improving knowledge and providing technical solutions.

v. Micro-learning Security and Privacy

While we acknowledge and advocate for trust-based solutions such as the Mfunzi application at Mzumbe University, there are limited voices from the learners and educators on the need to authenticate them to use the system. As we have discussed during the Ujuzi App evaluation, some users confirm their need for applications that can be used without having to authenticate. This is an alternative area of research to explore the impact of the authentication processes on the users' decision to use the application. Is security problematic to some people? Are we witnessing the continuation of the long-standing debate between security and privacy: which one should be given priority?

The above suggestions are just the starting points towards micro-learning improvements. We believe that readers and scholars will find other interesting and relevant areas of studies to build upon this work.

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ANNEXE 3.1

RESEARCH CLEARANCE

UBi9ERSITY OF DAR ES SALAAM

DIRECTORATE OF RESEARCH AND PUBLICATION

P.O. Box 35091 • DA R ES SALAAM • TANZANIA

De L g 241 500-8 Ext. 2084 ee ne — Fax: 255 022 2410743 / 255 022 2410023

Website: www.udsm.ac.tz — E-mail: research@udsm.ac.tz

Our Ref. AB3/31 — 15th August 2018

Principal
Dar es Salaam College of Education (DUCE)
University of Dar es Salaam

RE: RESEARCH CLEARANCE

This is to introduce Air. Mohamed Abdulrahman Ghasia who is a staff of Mzumbe University pursuing PhD Studies at the Ghent University Belgium. Mr. Ghasia is at the moment conducting data collection as part of his research study. The title of his research is 'Developing Mobile Learning Deployment Model for Higher Learning Institutions in Tanzania'.

This is to request you to grant the above-mentioned researcher any help that may enable him to achieve his study objectives. The period for which this permission has been granted is from August to December 2018.

Dr. Christine Noe
RESEARCH AND PUBLICATION

cc: **Vice Chancellor**
cc: **Deputy Vice Chancellor - Academic**
cc: **Deputy Vice Chancellor - Administration**
cc: **Deputy Vice Chancellor - Research**

MZUMBE UNIVERSITY

OFFICE OF THE VICE CHANCELLOR

Tel: +255 (0) 23 2604380/1/3/4 — P.O.BOX 63
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Email: dpgs@mzumbe.ac.tz
Website: www.mzumbe.ac.tz

Ref.No. MU/DRPS/DPGS/PhD/39/ — Date, 27th September, 2016

Officeofthe ViceChancellor,
Open University of Tanzania,
DAR ES SALAAM.

RE: INTRODUCTION OF MR. MOHAMED ABDULRAHMAN GHASIA

May I please, draw your attention to the above caption.

The bearer of this letter is a Staff of Mzumbe University pursuing PhD Studies at the Ghent University Belgium. As a part of requirements for completion of his studies, he is collecting information (researching) on " *Developing mob??e learning deployment model for higher learn?ng institutions in Tanzania.*" This exercise is expected to take place between October, 2016 to January, 2017.

This letter serves to achieve three purposes. Firstly, to introduce him to you; secondly to request you to grant him permission to undertake the research in your organization, and thirdly to request you to facilitate any form of assistance he might need during this exercise. We can assure you that this activity is entirely for academic purposes and that the information collected will never be used for any other purpose than academic.

We trust that you will accord our student with necessary assistance.

Should you have any query, please contact this office for clarification.

Sincerely yours,

Dr. Erasmus Fabian Kipesha (PhD)
For: VICE CHANCELLOR

THE UNIVERSITY OF DODOMA

OFFICE OF THE DEPUTY VICE CHANCELLOR - ARC
DIRECTORATE OF RESEARCH AND PUBLICATIONS, INNOVATION, CONSULTANCY AND COLLABORATION
P.O. BOX 259,
DODOMA, TANZANIA
TEL: +255 26 2310001 FAX: +255 26 2310002 WEBSITE: www.udom.ac.tz

REF UDOM/DRP/134 Vol. II /36 — [illegible]

To: Principals — CoED and CHSS
Director — ICT
The University of Dodoma

RE: PERMISSION FOR MR. MOHAMED A. GHASIA AND MR. EDGER RUTATOLA TO COLLECT INFORMATION ON RESEARCH ENTITLED *"Developing Mobile Learning Deployment Model for Higher Learning Institutions in Tanzania"*

Please refer to the heading above.

The above mentioned are researchers from Mzumbe University who were granted permission to collect information on Research entitled "Developing Mobile Learning Deployment Model for Higher Learning Institutions in Tanzania", from the College of Informatics and Virtual Education.

In addition, the researchers have requested to conduct the same activity at the College of Education, College of Humanities and Social Sciences and at the Directorate of Information Communication Technology. I attach the permission letter to conduct research at UDOM — CIVE for your reference.

I kindly request your office to assist them.

Sincerely

Dr. L. Mbwambo
Ag. Director, Research and [illegible], Innovation, Consultancy and Collaboration

cc: VC — UDOM
VC — Mzumbe University
DVC ARC

MZUMBE UNIVERSITY

OFFICE OF THE VICE CHANCELLOR

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Email: dpgs@mzumbe.ac.tz
Website: www.mzumbe.ac.tz

Ref. No. MU/DRPS/DPGS/PhD/39/53 — **Date: 13th March, 2017**

Office of the Vice Chancellor,
University of Dar es salaam,
P. O. Box 35091,
DAR ES SALAAM.

RE: INTRODUCTION OF MR. MOHAMED ABDULRAHMAN GHASIA

May I please, draw your attention to the above caption.

The bearer of this letter is a Staff of Mzumbe University pursuing PhD Studies at the Ghent University Belgium. As a part of requirements for completion of his studies, he is collecting information (researching) on" *Developing mobile learn/ng deployment model for higher learning institutions in Tanzania.*" This exercise is expected to take place between March, 2017 to April, 2017.

This letter serves to achieve three purposes. Firstly, to introduce him to you; secondly to request you to grant him permission to undertake the research in your organisation, and thirdly to request you to facilitate any form of assistance he might need during this exercise. We can assure you that this activity is entirely for academic purposes and that the information collected will never be used for any other purpose than academic.

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Sincerely yours,

Mr. Benjamin Lenan
For: VICE CHANCELLOR

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DIRECTORATE OF RESEARCH AND PUBLICATION

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Website: www.udsm.ac.tz E-mail: research@udsm.ac.tz

Our Ref. AB3/31 15th August 2019

Principal
Dar es Salaam College of Education (DUCE)
University of Dar es Salaam

RE: RESEARCH CLEARANCE

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Dr. Christine Noe
RESEARCH AIID PUBLICATION

cc: Vice Chancellor
cc: Deputy Vice Chancellor - Academic
cc: Deputy Vice Chancellor - Administration
cc: Deputy Vice Chancellor - Research

MZUMBE UNIVERSITY

OFFICE OF THE VICE CHANCELLOR

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MOROGORO, TANZANIA

Ref.No. MU/DRPS/DPGS/PhD/39/ Date, 27th September 2016

Officeofthe ViceChancellor,
Open University of Tanzania,
DAR ES SALAAM.

RE: INTRODUCTION OF MR. MOHAMED ABDULRAHMAN GHASIA

May I please, draw your attention to the above caption.

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We trust that you will accord our student with necessary assistance.

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Sincerely yours,

Dr. Erasmus Fabian Kipesha (PhD)
For: VICE CHANCELLOR

THE OPEN UNIVERSITY OF TANZANIA

Directorate of Research and Publications

I*.O. Box 23409
Ba.i Es Salaam
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Tel.: +258 -22 2668992/2668445
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ext.
Email: drp@out.ac.tz

Ref. No. OUT/DRP/RC/1 1/2018 Date: 20'' August, 2018

DHRM

P.O. Box
23409 DAR ES
SALAAM

Dear Sir/ Madam,

RE: RESEARCH CLEARANCE AND DATA COLLECTION

This letter is written to allow Mr. ñJohamed Abdulrahman Ghasia from Ghent University of Belgium. to collect dita at 'flue Open University of Tanzania, and write a report as a part of requirements for completion of his studies.

His research title is *"Developing Mobile Leaning Development MoJel for High Leaning Institutions in Tiuizania."*. The exerci se will be taking place between August, 2018 to December, 2018.

It is my hope that Mr. Mohamed Abdulrahman Ghasia will be accorded the necessary cooperation in relevantd epartments.

Yours Sincerely,

Dr. Fauzia Mohamed
Research Coordinator

cc DCV-Academic OUT
DVC-RM OUT
IEMT

MZUMBE UNIVERSITY

OFFICE OF THE VICECHANCELLOR

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MOROGORO, TANZANIA

RefNo. MU/DRPS/DPGS/PhD/39/ **Date: 27th September, 2016**

TOWHOMITMAYCONCERN

RE: INTRODUCTION OF MR. MOHAMED ABDULRAHMAN GHASIA

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For: VICE CHANCELLOR

UNIVERSITY OF DAR ES SALAAM

DIRECTORATE OF RESEARCH AND PUBLICATION

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E-mail: *research@udsm.ac.tz*

Our Ref. AB3/31

15th August 2018

Principal
Dar es Salaam College of Education (DUCE)
University of Dar es Salaam

RE: RESEARCH CLEARANCE

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This is to request you to grant the above-mentioned researcher any help that may enable him to achieve his study objectives. The period for which this permission has been granted is from **August to December 2018.**

Dr. Christine Noe
DIRECTOR OF RESEARCH AND PUBLICATION

cc: Vice Chancellor
cc: Deputy Vice Chancellor - Academic
cc: Deputy Vice Chancellor - Administration

ANNEXE 4.1

SURVEY QUESTIONS TO THE EDUCATORS, STUDENTS AND TECHNOLOGISTS

A. Questionnaire (Student)

Introduction

I am a PhD student at Ghent University in Belgium and an employee of Mzumbe University I am humbly requesting for your time and effort in providing me with information that will be used in my study on "**Developing micro-mobile learning deployment model for higher education institutions in Tanzania".** As we are the witness to how development in the area of mobile technology is influencing changes in our social-economic sectors, this study is focused on the education sector especially higher learning institution. Our motivation is on learning the right approach in deploying the said technologies for the betterment of the institutions, educators as well as the learners.

It is my hope that you will be pleased to be part of this journey. I would like to confirm that the data provided in this study will be used academically and according to ethical standards observed by all research institutions. Mzumbe and Ghent Universities demand a high degree of confidentiality and anonymity of the respondents.

With thanks,

Mohamed Abdulrahman Ghasia

A: Personal Information: Please fill in the blanks, cycle or tick (√) the appropriate box

1.1 Name: ---------- (optional)

1.2 Age Group (years):

18 - 25	26 -34	35 - 40	41- 45	45 & above

1.3 Sex: Male [ ] Female [ ]

1.4 Course/programme:----------

---------- Study year ----------

1.5 Faculty/School/Directorate/ Institution:

……

2.0 The extent of micro-learning deployment in Tanzanian universities

2.1 Please give your opinions in each of the following statements based on your level of awareness of micro-learning: 1 = Strongly Unaware, 2 = Unaware, 3 = Neutral, 4 = Aware, 5 = Strongly Aware

	Awareness towards Micro-learning	1	2	3	4	5
1	I am aware of micro-learning					
2	The benefits of applying micro-learning					
3	The duration and design of the micro-learning content are the vital components					
4	Micro-learning and e-learning are not the same concepts					
5	Micro-learning is the most deserved pedagogical approach for my situation					
6	Micro-learning can be implemented using current Learning management systems (LMS) such as Moodle.					

2.2 Please give your opinions in each of the following statements based on micro-learning experience: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Experience with micro-learning	1	2	3	4	5
1	I have experience with micro-learning					
2	My university offers micro-learning content in some modules /courses					
3	I often use micro-learning videos from www.youtube.com					
4	It is impossible to learn through mobile devices such as smartphones					
5	I have accessed micro-learning contents from various local providers (issuers)					
6	I don't have the habit of accessing online contents by using my mobile devices					

2.3 Please give your opinions in each of the following statements concerning your frequency on micro-learning use: 1 = Rarely, 2 = Occasionally, 3 = Neutral, 4 = Frequently, 5 = Very Frequently

	Frequency of use micro-learning	1	2	3	4	5
1	I rely on online materials to expand my understanding of materials offered in class					
2	I rely on my mobile phone to access scholarly resources and more					
3	I access online learning resources by using my mobile phone					
4	I collaborate with fellow learners and experts through various social media					
5	I access micro-learning contents from various local providers (issuers)					
6	I rely on the university infrastructure to access online learning resources					
7	I turn into online resources to learn new skills					

2.4 Please give your opinions in each of the following statements based on micro-learning challenges (issues): 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Issues with micro-learning	1	2	3	4	5
1	Locating micro-content(s) offered by the Tanzanian institutions					
2	Identifying authentic issuers (providers) of the micro-learning services					
3	Paying for the sold Micro-learning contents/services					
4	Keeping with the changing pace of the micro-learning content worldwide					
5	Availability of the competent instructional designers & developers of micro-contents					
6	Availability of relevant infrastructure to support micro-learning					
7	Existence of necessary institutional policies tailored towards micro-learning					
8	Existence of necessary national policies tailored towards micro-learning					

2.5 What do you like about micro-learning (you can check as many as possible)?

Ability to learn anywhere and anytime	
The ability to learn in a short-time slots	
Micro-learning focuses on one learning objective at a time	
The interactivity that comes with quiz	
Ability to learn through mobile devices such as smartphones and tablets	
Other (Please specify) …… ……..	

2.6 Please give your opinions in each of the following statements based on the availability of micro-learning: 1 = Very untrue, 2 = Untrue, 3 = Neutral, 4 = True, 5 = Very true

	Availability of Micro-learning	1	2	3	4	5
1	My university is integrating micro-learning into courses					
2	I supplement my learning experience with micro-learning videos from the Internet					
3	Lecturer(s) recommend relevant micro-learning contents for us					
4	I know several issuers (providers) of micro-learning services					
5	Mobile-based micro-learning are commonly offered in Tanzanian universities					

2.7 Please give your opinions in each of the following statements based on micro-learning accessibility: 1 = Very untrue, 2 = Untrue, 3 = Neutral, 4 = True, 5 = Very true

	Accessibility of micro-learning	1	2	3	4	5
1	My university offers enough connected computers to access online contents					
2	I need to be at the university to access micro-learning services offered by my university					
3	I can easily access the university-based learning management systems (LMS eg Moodle, Blackboard)					
4	I cannot use my mobile devices (smartphone, tablet) to access micro-learning sites					
5	The quality of the mobile Internet in Tanzania is sufficient for the micro-learning sessions					
6	I can confirm that paying for the mobile Internet (bundle) is not a problem for me					
7	I rely on the university infrastructure to online learning resources					

2.8 Please give your opinions in each of the following statements based on the attitude towards micro-learning: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Attitude towards micro-mobile learning	1	2	3	4	5
1	I like the concept behind micro-learning					
2	I can recommend the use of micro-learning to all sectors					
3	Micro-learning destructs students from deep learning					
4	I prefer mobile-based micro-learning more than computer-based					
5	I believe that micro-mobile learning is so relevant in resource-constrained societies/countries					
6	Micro-learning inspires lifelong learning					
7	I would consider purchasing micro-learning services from reputable issuers (providers)					

3. Factors influencing micro-learning implementation in Tanzanian universities

3.1 To what extent do you conform to the following statements concerning reasons for micro-learning deployment/implementation? Use the scale 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Reason for micro-learning implementation	1	2	3	4	5
1	Enhancing access to learning resources and activities					
2	Imparting specific skills to learners					
3	Enhancing retention capacity of the learners					
4	Complimenting the existing learning approaches					
5	Improving the quality of learning experiences					
6	Micro-learning are the true means for learning anywhere, anytime and any-pace					

3.2 To what extent do you conform to the following statements regarding the influence of technological characteristics into micro-learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Technological characteristics	1	2	3	4	5
1	Learning technologies should be easy to use					
2	The features of a learning technology should reflect the need of the users					
3	The deployed technology should be compatible with my devices (mobile/PC)					
4	The newly deployed technologies should be compatible with the existing media formats (video, text, audio etc)					
5	Social interactivity with educators or learners is vital for any learning platform					
6	It is crucial that technologies should be accessible anywhere and anytime					
7	Deployed technology should be compatible with the business goals					

3.3 To what extent do you conform to the following statements regarding the influence of user characteristics in effective micro-learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	User characteristics	1	2	3	4	5
1	Skilled learners contribute to the positive output					
2	Learners who are capable of paying for services simplifies the transformation process					
3	Learners who are hesitant to try out new technologies for learning are the problem					
4	The willingness to use culture among learners					
5	Poverty affects the willingness to use the learning platforms					
6	My friends or lecturers have the power to influence my decision to use technologies					

3.4 To what extent do the following pedagogical attributes influence effective micro-mobile learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Pedagogical Attributes	1	2	3	4	5
1	The integration of learning technologies into the course design					
2	The existence of the well-stipulated learning outcomes					
3	The pedagogical belief of the lecturers					
4	The ability of student to relate online learning and learning strategy					
5	The pedagogical competence of the lecturer					
6	Digital literacy of the learner					

3.5 To what extent do the following Institutional characteristics influence effective micro-mobile learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Institutional Characteristics	1	2	3	4	5
1	Budget to support e-learning related activities such as training of learners prior to using online learning					
2	Budget to support technology deployment					
3	Policies tailored towards wide acceptance and utilization of online learning					
4	The ability to commit to a vision of implementing and using online learning in learning					
5	The leadership attitude towards innovations or technologies					
6	The leaders' competency in technologies					
7	The existence of relevant infrastructure to support micro-learning					
8	The culture of the institution towards learning technologies					

- **Thank you so much for your time**

B. Questionnaire (Academic Staff)

Introduction

I am a PhD student at Ghent University in Belgium and an employee of Mzumbe University I am humbly requesting for your time and effort in providing me with information that will be used in my study on "**Developing micro-mobile learning deployment model for higher education institutions in Tanzania".** As we are the witness to how development in the area of mobile technology is influencing changes in our social-economic sectors, this study is focused on the education sector especially higher learning institution. Our motivation is on learning the right approach in deploying the said technologies for the betterment of the institutions, educators as well as the learners.

It is my hope that you will be pleased to be part of this journey. I would like to confirm that the data provided in this study will be used academically and according to ethical standards observed by all research institutions. Mzumbe and Ghent Universities demand a high degree of confidentiality and anonymity of the respondents.

With thanks,

Mohamed Abdulrahman Ghasia

A: Personal Information: Please fill in the blanks, cycle or tick (√) the appropriate box

1.0 Background Information

1.1 Name of the University ……. …….....……

1.2 Sex (Tick) ( ) Male ( ) Female

1.3 Academic Staff Category (Tick) ( ) Tutorial Assistant, ( ) Assistant Lecturer ( ) Lecturer ( ) Associate Professor, ( ) Professor

1.4 Age Group: (Tick) ( ) Below 30, ( ) 30 – 40, ( ) 41 – 50, ( ) Above 50

1.5 Educational level (Tick) ( ) Bachelor Degree, ( ) Master Degree ( ) PhD

1.6 Area of specialization……..e.g (Computer science, Sociology, Law, Civil e.t.c)

2.0 The extent of Micro-learning uptake in Tanzanian universities

2.1 Please give your opinions in each of the following statements based on awareness of e-learning: 1 = Strongly Unaware , 2 = Unaware, 3 = Neutral, 4 = Aware, 5 = Strongly Aware

	Awareness towards Micro-learning	1	2	3	4	5
1	I am aware of micro-learning					
2	The benefits of applying micro-learning					
3	The duration and design of the micro-learning content are the vital components					
4	Micro-learning and e-learning are not the same concepts					
5	Micro-learning is the most deserved pedagogical approach for my situation					
6	Micro-learning can be implemented using current Learning management systems (LMS) such as Moodle.					

2.2 Please give your opinions in each of the following statements based on micro-learning experience: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Experience with micro-learning	1	2	3	4	5
1	I have experience with micro-learning					
2	My university offers micro-learning content in some modules /courses					
3	I often recommend useful micro-content to my students					
4	I have the necessary skills to prepare micro-learning contents					
5	I have accessed micro-learning contents from various local providers (issuers)					
6	I don't have a habit of accessing online contents by using my mobile devices					
7	I have participated in offering micro-contents to students in my class					

2.3 Please give your opinions in each of the following statements concerning your frequency on micro-learning use: 1 = Rarely, 2 = Occasionally, 3 = Neutral, 4 = Frequently, 5 = Very Frequently

	Frequency of use micro-learning	1	2	3	4	5
1	I rely on online materials to expand my understanding concepts					
2	I rely on my mobile phone to access scholarly resources and more					
3	I access online learning resources by using my mobile phone					
4	I collaborate with fellow educators and learners through various social media platforms					
5	I access micro-learning contents from various local providers (issuers)					
6	I rely on the university infrastructure to access online learning resources					
7	I enjoy learning through short learning contents of various formats videos, texts, infographic materials etc					

2.4 Please give your opinions in each of the following statements based on micro-learning challenges (issues: 1) = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Issues with micro-learning	1	2	3	4	5
1	Locating micro-content(s) offered by the Tanzanian institutions					
2	Identifying authentic issuers (providers) of micro-learning services					
3	Paying for the sold micro-learning contents/services					
4	Keeping with the changing pace of the micro-learning content worldwide					
5	Availability of the competent instructional designers & developers of micro-contents					
6	Availability of relevant infrastructure to support micro-learning					
7	Existence of necessary institutional policies tailored towards micro-learning					
8	Existence of necessary national policies tailored towards micro-learning					

2.5 What do you like about micro-learning (you can check as many as possible)?

Ability to learn anywhere and anytime	
The ability to learn in a short-time slots	
Micro-learning focuses on one learning objective at a time	
The interactivity that comes with quiz	
Ability to learn through mobile devices such as smartphones and tablets	
Other (Please specify) …… ……..	

2.6 Please give your opinions in each of the following statements based on the availability of micro-learning: 1 = Very untrue, 2 = Untrue, 3 = Neutral, 4 = True, 5 = Very true

	Availability of Micro-learning	1	2	3	4	5
1	My university is integrating micro-learning into courses					
2	I supplement my learning experience with micro-learning videos from the Internet					
3	I usually recommend relevant micro-learning contents to my students					
4	I know several issuers (providers) of micro-learning services					
5	Mobile-based micro-learning are commonly offered in Tanzanian universities					

2.7 Please give your opinions in each of the following statements based on micro-learning accessibility: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Accessibility of micro-learning	1	2	3	4	5
1	My university offers enough connected computers to access online contents					
2	I need to be at the university to access micro-learning authoring tools					
3	I can easily access the university-based learning management systems (LMS eg Moodle, Blackboard) on the go					
4	I can use my mobile devices (smartphone, tablet) to access micro-learning sites					
5	The quality of the mobile Internet in Tanzania is sufficient for the micro-learning sessions					
6	I can confirm that paying for the mobile Internet (bundle) is not a problem for me					
7	I rely on the university infrastructure to online learning resources					

2.8 Please give your opinions in each of the following statements based on the attitude towards micro-learning: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Attitude towards micro-mobile learning	1	2	3	4	5
1	I like the philosophy behind micro-learning					
2	I can recommend the use of micro-learning to all sectors					
3	Micro-learning destructs students from deep learning					
4	I prefer mobile-based micro-learning more than computer-based					
5	I believe that micro-mobile learning is so relevant in resource-constrained societies/countries					
6	Micro-learning inspires lifelong learning					
7	I am willing to participate in offering free micro-learning contents					
8	If an opportunity arises, I am willing to prepare micro-contents for sell					

3. Factors influencing micro-learning implementation in Tanzanian universities

3.1 To what extent do you conform to the following statements concerning reasons for micro-mobile learning deployment/implementation? Use the scale 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Reason for micro-learning implementation	1	2	3	4	5
1	Enhancing access to learning resources and activities					
2	Imparting specific skills to learners					
3	Enhancing retention capacity of the learners					
4	Complimenting the existing learning approaches					
5	Improving the quality of learning experiences					
6	True means for learning anywhere, anytime and any-pace					

3.2 To what extent do you conform to the following statements regarding the influence of technological characteristics into micro-learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Technological characteristics	1	2	3	4	5
1	Learning technologies should be easy to use					
2	The features of a learning technology should reflect the need of the users					
3	The deployed technology should be compatible with my devices (mobile/PC)					
4	The newly deployed technologies should be compatible with the existing media formats (video, text, audio etc)					
5	Social interactivity with educators or learners is vital for any learning platform					
6	It is crucial that technologies should be accessible anywhere and anytime					
7	Deployed technology should be compatible with the business goals					

3.3 To what extent do you conform to the following statements regarding the influence of user characteristics in effective micro-learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	User characteristics	1	2	3	4	5
1	Skilled educators contribute to the positive output					
2	lecturers have the ability to influence student's use of technology					
3	I am hesitant to applying micro-learning in my class					
4	The willingness to use culture among learners					
5	Digital natives are more inclined to use technology than digital immigrants					
6	I cannot use my personal devices to fulfil the university-related duties					

3.4 To what extent do the following pedagogical attributes influence effective micro-mobile learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Pedagogical Attributes	1	2	3	4	5
1	The integration of learning technologies into the course design					
2	The existence of the well-stipulated learning outcomes					
3	The pedagogical belief of the lecturers					

4	The involvement of the educators in the deployment process					
5	The pedagogical competence of the lecturer					
6	Digital literacy of the educators					
7	The educator's innovativeness					

3.5 To what extent do the following Institutional characteristics influence effective micro-mobile learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Institutional Characteristics	1	2	3	4	5
1	Budget to support e-learning related activities such as training of learners prior to using online learning					
2	Budget to support technology deployment					
3	Policies tailored towards wide acceptance and utilization of online learning					
4	The ability to commit to a vision of implementing and using online learning in learning					
5	The leadership attitude towards innovations or technologies					
6	The leaders' competency in technologies					
7	The existence of relevant infrastructure to support micro-learning					
8	The culture of the institution towards learning technologies					

- Thank you so much for your time –

C. Questionnaire (Technologist)

Introduction

I am a PhD student at Ghent University in Belgium and an employee of Mzumbe University I am humbly requesting for your time and effort in providing me with information that will be used in my study on "**Developing micro-learning deployment model for higher education institutions in Tanzania".** As we are the witness to how development in the area of mobile technology is influencing changes in our social-economic sectors, this study is focused on the education sector especially higher learning institution. Our motivation is on learning the right approach in deploying the said technologies for the betterment of the institutions, educators as well as the learners.

It is my hope that you will be pleased to be part of this journey. I would like to confirm that the data provided in this study will be used academically and according to ethical standards observed by all research institutions. Mzumbe and Ghent Universities demand a high degree of confidentiality and anonymity of the respondents.

With thanks,

Mohamed Abdulrahman Ghasia

A: Personal Information: Please fill in the blanks, cycle or tick (√) the appropriate box

1.0 Background Information

1.1 Name of the University ……. …….....……

1.2 Sex (Tick) ( ) Male ( ) Female

1.3 Occupation Title:

……..

1.4 Age Group: (Tick) ( ) Below 30, ( ) 30 – 40, ( ) 41 – 50, ( ) Above 50

1.5 Educational level (Tick) ( ) Bachelor Degree, ( ) Masers Degree ( ) PhD

1.6 Area of specialization……..

2.0 The extent of Micro-learning uptake in Tanzanian universities

2.1 Please give your opinions in each of the following statements based on your level of awareness of micro-mobile learning: 1 = Strongly Unaware, 2 = Unaware, 3 = Neutral, 4 = Aware, 5 = Strongly Aware

	Awareness towards Micro-learning	1	2	3	4	5
1	I am aware of micro-learning					
2	The benefits of applying micro-learning					
3	The duration and design of the micro-learning content are the vital components					
4	Micro-learning and e-learning are not the same concepts					
5	Micro-learning is the most deserved pedagogical approach for my situation					
6	Micro-learning can be implemented using current Learning management systems (LMS) such as Moodle.					

2.2 Please give your opinions in each of the following statements based on micro-learning experience: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Experience with micro-learning	1	2	3	4	5
1	I have experience with micro-learning					
2	My university offers micro-learning content in some modules /courses					
4	I have the necessary skills to prepare micro-learning contents					
5	I have accessed micro-learning contents from various local providers (issuers)					
6	I don't have a habit of accessing online contents by using my mobile devices					
7	I participate in the offering of micro-contents to students					
8	I support lecturers on micro-learning authoring					

2.3 Please give your opinions in each of the following statements concerning your frequency on micro-learning use: 1 = Rarel, 2 = Occasionally, 3 = Neutral, 4 = Frequently, 5 = Very Frequently

	Frequency of use micro-learning	1	2	3	4	5
1	I rely on online materials to expand my understanding concepts					
2	I rely on my mobile phone to access online tutorials related to my work					
3	I collaborate with fellow experts through various social media platforms					
4	I access micro-learning contents from various local providers (issuers)					
5	I rely on the university infrastructure to access online learning resources					
6	I enjoy learning through short learning contents of various formats videos, texts, infographic materials etc					

2.4 Please give your opinions in each of the following statements based on micro-learning challenges (issues: 1) = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Issues with micro-learning	1	2	3	4	5
1	Locating micro-content(s) offered by the Tanzanian institutions					
2	Identifying authentic issuers (providers) of micro-learning services					
3	Existence of enough number of skilled manpower					
4	Low adoption rate from the academic staff					
5	Availability of the competent instructional designers & developers of micro-contents					
6	Availability of relevant infrastructure to support micro-learning					
7	Existence of necessary institutional policies tailored towards micro-learning					
8	Existence of necessary national policies tailored towards micro-learning					
9	Digital illiteracy amongst players					

2.5 What do you like about micro-learning (you can check as many as possible)?

Ability to learn anywhere and anytime	
The ability to learn in a short-time slots	
Micro-learning focuses on one learning objective at a time	
The interactivity that comes with quiz	
Ability to learn through mobile devices such as smartphones and tablets	
Other (Please specify) …… ……..	

2.6 Please give your opinions in each of the following statements based on the availability of micro-learning: 1 = Very untrue, 2 = Untrue, 3 = Neutral, 4 = True, 5 = Very true

	Availability of Micro-learning	1	2	3	4	5
1	My university is integrating micro-learning into courses					
2	My university hosts satisfactory infrastructure to support micro-learning					
3	We offer enough support to the users of micro-learning					
4	I know other issuers (providers) of micro-learning services					
5	Mobile-based micro-learning are commonly offered in Tanzanian universities					
6	My university is capable of paying for the micro-learning systems					

2.7 Please give your opinions in each of the following statements based on micro-learning accessibility: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Accessibility of micro-learning	1	2	3	4	5
1	My university offers enough connected computers to access online contents					
2	Users need to be at the university to access micro-learning authoring tools					
3	We offer directives on how/where to access micro-learning services					
4	Micro-learning services are not accessible on mobiles (smartphone, tablet)					
5	The quality of the mobile Internet in Tanzania is sufficient for the micro-learning sessions					
6	I can confirm that paying for the mobile Internet (bundle) is not a problem for me					
7	The university Wi-Fi is sufficient to access online services					

2.8 Please give your opinions in each of the following statements based on the attitude towards micro-learning: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Attitude towards micro-mobile learning	1	2	3	4	5
1	I like the philosophy behind micro-learning					
2	I can recommend the use of micro-learning to all sectors					
3	Micro-learning destructs students from deep learning					
4	I prefer mobile-based micro-learning more than computer-based					
5	I believe that micro-mobile learning is so relevant in resource-constrained societies/countries					
6	Micro-learning inspires lifelong learning					
7	I am willing to participate in offering free micro-learning contents					
8	If an opportunity arises, I am willing to prepare micro-contents for sell					

3. Factors influencing micro-learning implementation in Tanzanian universities

3.1 To what extent do you conform to the following statements concerning reasons for micro-mobile learning deployment/implementation? Use the scale 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	Reason for micro-learning implementation	1	2	3	4	5
1	Enhancing access to learning resources and activities					
2	Imparting specific skills to learners					

3	Enhancing retention capacity of the learners					
4	Complimenting the existing learning approaches					
5	Improving the quality of learning experiences					
6	True means for learning anywhere, anytime and any-pace					

3.2 To what extent do you conform to the following statements regarding the influence of technological characteristics into micro-learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Technological characteristics	1	2	3	4	5
1	Learning technologies should be easy to use					
2	The features of a learning technology should reflect the need of the users					
3	The deployed technology should be compatible with users devices (mobile/PC)					
4	The newly deployed technologies should be compatible with the existing media formats (video, text, audio etc)					
5	Social interactivity with educators or learners is vital for any learning platform					
6	It is crucial that technologies should be accessible anywhere and anytime					
7	Deployed technology should be compatible with the business goals					

3.3 To what extent do you conform to the following statements regarding the influence of user characteristics in effective micro-learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	User characteristics	1	2	3	4	5
1	Skilled educators contribute to the positive output					
2	lecturers have the ability to influence student's use of technology					
3	Students are more reluctant to use technologies than lecturers					
4	The un-willingness to use culture among learners					
5	Younger generation are likely to use technology than older generations					
6	Users are reluctant to use their personal devices to fulfil the university-related duties					

3.4 To what extent do the following pedagogical attributes influence effective micro-mobile learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Pedagogical Attributes	1	2	3	4	5
1	The integration of learning technologies into the course design					
2	The existence of the well-stipulated learning outcomes					
3	The pedagogical belief of the lecturers					
4	The involvement of the educators in the deployment process					
5	The pedagogical competence of the lecturer					
6	Digital literacy of the educators					
7	The educator's innovativeness					

3.5 To what extent do the following Institutional characteristics influence effective micro-mobile learning implementation? Use the scale 1=Very Low (VL), 2=Low (L), 3=No Idea (NI), 4=High (H) and 5=Very High (VH)

	Institutional Characteristics	1	2	3	4	5
1	Budget to support e-learning related activities such as training of learners prior to using online learning					
2	Budget to support technology deployment					
3	Policies tailored towards wide acceptance and utilization of online learning					
4	The ability to commit to a vision of implementing and using online learning in learning					
5	The leadership attitude towards innovations or technologies					
6	The leaders' competency in technologies					
7	The existence of relevant infrastructure to support micro-learning					
8	The culture of the institution towards learning technologies					

- Thank you so much for your time -

ANNEXE 4.2

A. INTERVIEW GUIDE (Student)

1. What is your name, what are you studying, and how do you feel about studying at this university?
2. Can you explain a bit about your ICT knowledge?
3. Can you describe when did you start using mobile devices and how conversant (competent) are you in using mobile devices such as Smartphone?
4. How conversant are you with the Internet? How do you use the Internet?
5. What do you know about e-learning & micro-learning? Have you ever used your mobile for learning-related activities? What is your opinion about learning through mobile?
6. Have you ever used online materials to complement what you have learnt in class? How often?
7. How are the online materials different from that you learn in class?
8. Micro-lessons are skill-based, focused on the single specific learning outcome, short lessons, and run within short time slots approximately up to 15.
9. How is learning online different from that you do in class?
10. What do you think about the introduction of micro-learning in your courses?
11. What is your preferred mode of delivery between computer-based micro-learning or mobile-based micro-learning? Why?
12. Should micro-learning be deployed independently or integrated within existing modules?
13. Have you ever participated in micro-learning? What do you think about the ability of students to pay for the devices and the Internet (bundle)?
14. What do you think about the university infrastructure, lecturers' attitudes and culture with regards to online learning?
15. What do you think if some of what you learn in class is to be delivered through short micro-lessons to inspire skills?
16. What should be in place for the micro-learning to be a reality in your university?
17. Can you describe students' attitude towards learning through technologies?
18. Taking short youtube videos as a model for micro-learning, how appropriate is it for your career development?
19. Would you consider paying for micro-learning services?
20. What do you know about micro-credentials (digital badges)?
21. We apply micro-credentials to recognize one's skills and achievements. What does it mean to students?
22. What is your experience with micro-credentials?
23. We have discussed a number of topics; please do you have anything to add to what we have covered?

-Thank you so much -

B. INTERVIEW GUIDE (Academic Staff)

1. I would like to know better about your job and experience.
2. When did you start using mobile devices such as Smartphone (you can just approximate)? How conversant are you with the ICTs and the Internet? How do you use them?
3. As an educator, how do you perceive the emergence of mobile technologies in our academic environment?
4. Have you ever been involved in teaching or learning with technology? LMS or mobile devices etc what do you think about it?
5. What do you know about e-learning and micro-learning?
6. What do you think about the design of the courses? Do they offer a chance for the micro-learning?
7. Let us move to the new concept: Micro-credentials, what do you know about it?
8. Are you conversant with digital-badges?

   Note: if the answer to 8/9 is no. Explain the concept and ask the relevancy in education
9. Micro-credentials (digital badges) focus on recognizing skills, achievements as well as accomplishments. Where does it fit in higher education?
10. When it started, Micro-credentials were used for professional development especially to recognize teachers' achievements. Do you see it happening in Tanzania?
11. What do you think about the prospect of introducing micro-credentials in Tanzania's higher learning Institutions? What do you think about the role of TCU in this?
12. In other parts of the world, micro-credentials are used to recognize the skills and accomplishments of those outside the formal education system. For example, an ordinary entrepreneur can demonstrate his/her skills and be awarded university-based credentials. What do you think about it in relation to our universities?
13. By considering the infrastructure, skills, attitude, policies as well as other pedagogical issues, is your institution and others in Tanzania ready (capable) for the offering of micro-credentials?
14. Are the existing policies (institutional & national) permit for the deployment of micro-credentials
15. Will the introduction of the digital-badges inspire students' innovativeness or skill-based self-learning?
16. In what capacities can the introduction of micro-credentials help the education systems in Tanzania?
17. If implemented, where or how should it be implemented?
18. Does the university have relevant skills to support micro-credentials implementation?
19. What can you say about the university leadership in terms of supporting innovations like micro-credentials?
20. Would you consider taking part in the issuance of micro-learning /micro-credentials?
21. We have discussed a number of topics; please do you have anything to add or if you have any advice

-Thank you so much-

C. INTERVIEW GUIDE (Technologist)

1. I would like to know better about your job and experience.
2. What is your view about the value of ICTs and the Internet in higher education?
3. What role do you play in the deployment of ICTs and learning technology in the university?
4. What kind of learning technologies are you aware of? How relevant are they?
5. What do you know about micro-learning and micro-credentials?
6. Have you ever participated in any of micro-credentials or micro-learning activities?
7. What role do you play in micro-learning or micro-credential deployment?
8. What do you think about lecturers' ability to participate in the processes of deploying micro-learning / micro-credentials?
9. What are the attitude of the learners and educators in regard to deployed learning technologies?
10. What is the state of the infrastructure in regards to micro-learning and micro-credentials?
11. Does the university have enough skilled manpower to support the micro-credential deployment?
12. Do the existing policies (institutional & national) support micro-learning or micro-credentials deployment?
13. What can you say about the university leadership in terms of supporting innovations like micro-credentials?
14. Does the current design of the course support the integration of micro-credentials?
15. By considering the infrastructure, skills, attitude, policies as well as other pedagogical issues, is your institution and others in Tanzania ready (capable) for the offering of micro-credentials?
16. What roles can the micro-credentials play in higher education in Tanzania?
17. We have discussed a number of topics; please do you have anything to add or advise on micro-learning and micro-credentials deployment?

-Thank you so much-

D. INTERVIEW GUIDE (Management Staff)

1. I would like to know better about your job and experience.
2. Do you think mobile technologies have impacted your life and work? How?
3. Have you ever been involved in teaching or learning with technology? LMS etc what do you think about it?
4. What can you say about your university in terms of technology adoption?
5. Are there policies guiding the technology deployment? What are they?
6. What do you know about micro-learning, have you ever used you are mobile for teaching and learning related activities? What is your opinion about learning/teaching through mobile?
7. Based on your experience, describe the prospect of implementing micro-learning at the universities in Tanzania including this one. Consider human capital, skills, and infrastructure and alike…
8. Can you propose appropriate ways of using mobile devices in the learning context?
9. There are three common approaches to managing mobile learning services and initiatives at the university (centralized at the education unit, decentralized to each faculty/school, dedicated to ICT unit) what do you think is the right approach for mobile learning implementation/deployment?
10. From your understanding, if micro-learning is to be implemented at the university, will everything remain as they are now or we need to change some aspects? If so what needs to be changed?
11. What is the university profile in adopting, innovating, implementing IT-related changes in its operations?
12. Is there any rule or policy that relates to micro-learning deployment? What about the regulatory authority (TCU)?
13. What do you think is the right approach to deploying m-learning at the university?
14. Do you think mobile learning is implementable within current university structure, culture and resources? If changes are necessary what needs to change?
15. We have discussed a number of topics; please do you have anything to add or advise on mobile learning deployment?

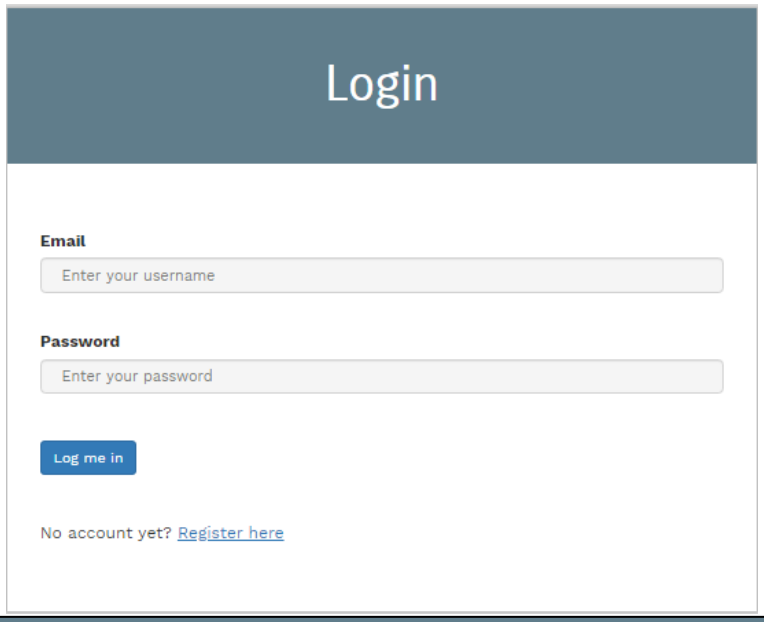
-Thank you so much-

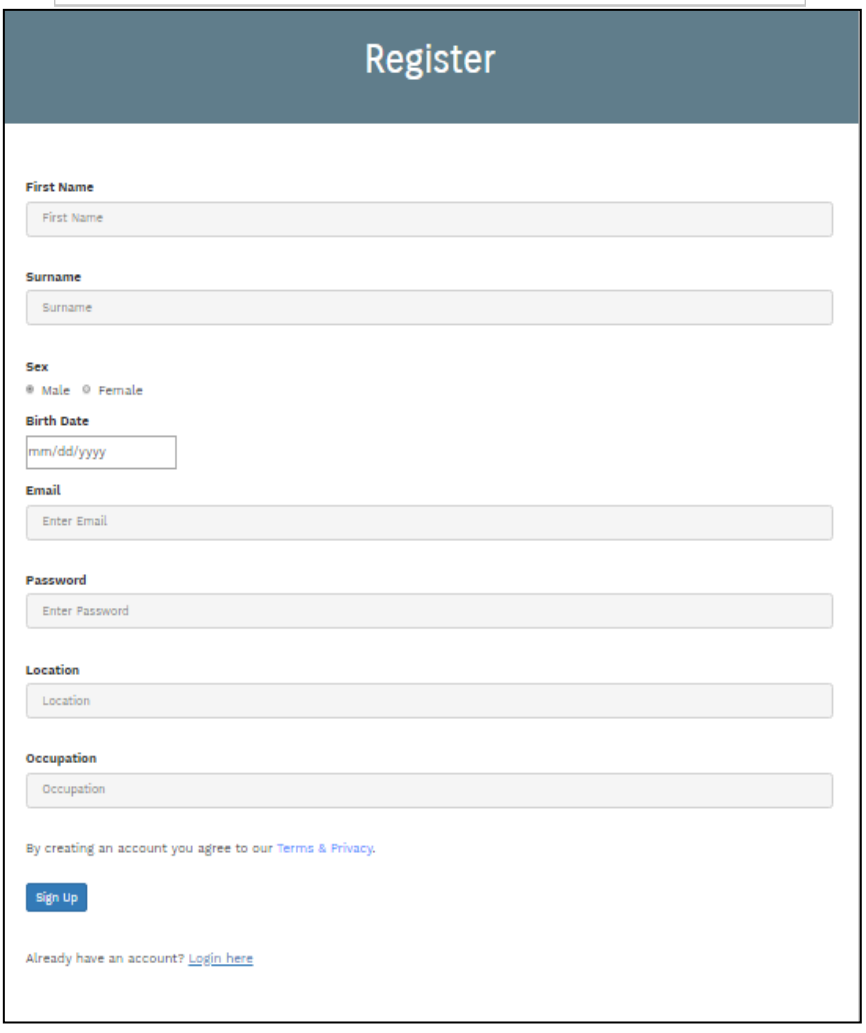
ANNEXE 6.1

UJUZI APP LOGO DESIGNS

ANNEXE 6.2

UJUZI APP AUTHENTICATION DETAILS





ANNEXE 6.3

A. UJUZI APP EVALUATION FORM (Technologist)

A: Personal Information: Please fill in the blanks, cycle or tick (√) the appropriate box

1.0 Background Information

1.1 Name of University ……. …….....……

1.2 Sex (Tick) ( ) Male ( ) Female

1.3 Academic Staff Category (Tick):

( ) Tutorial Assistant, ( ) Assistant Lecturer

( ) Lecturer ( ) Associate Professor, ( ) Professor

1.4 Age Group: (Tick)

( ) Below 30, ( ) 30 – 40, ( ) 41 – 50, ( ) Above 50

1.5 Educational level (Tick)

( ) Bachelor Degree, ( ) Masters Degree ( ) PhD

1.6 Area of specialization……..e.g (Networking, multimedia, EST.)

2.0 Device on which you used the app: ( ) Computer ( ) Smartphone ( ) Tablet

3.0 Please choose the answer that best represents your experience:

1 = Strongly Disagree, 2 = Disagree, 3= Somewhat Disagree 4 = Neutral, 5= somewhat agree, 6 = Agree, 7= Strongly Agree

	Feature	1	2	3	4	5
1	I found this app easy to use.					
2	I can use it without written instructions.					
3	I can navigate through the app easily.					
4	The language used in the app is easily understood.					
5	The app has adequate help documentation.					
6	The app does everything I would expect it to					
7	The app works the way I would want it to work.					
8	The app is designed for all levels of users.					
9	Using the app was an enjoyable experience.					
10	I found the app unnecessarily complex.					
11	I found the various functions in the app were well integrated.					
12	I think that I would use this app frequently.					
13	I felt very confident using this app.					

4. What did you learn from this app?

.....

5. Did the app answer all of your questions about the topics it covered? If not, what questions do you still have?

.....

6. What could improve the educational aspects of the app?

.....

7. List the most negative aspects of the app:

.....

8. List the most positive aspects of the app

.....
.....
.....
.....

9. What features should we add to improve the app?

.....

10. Overall experience of the App: (In each role choose the correct word or x level)						
1	Terrible	x	x	x	x	Wonderful
2	Difficult	x	x	x	x	Easy
3	Frustrating	x	x	x	x	Satisfying
4	Dull	x	x	x	x	Stimulating

11. I would recommend this app to a friend:
( ) Yes ( ) No

12. Any Comments, opinions, suggestions:

.....
.....
.....
.....
.....
.....

....Thank you so much for your time...

Adopted from https://www.surveymonkey.com/r/si-mobile-app-evaluation (1/9/2019)

B. UJUZI APP EVALUATION FORM (Student)

A: Personal Information: Please fill in the blanks, cycle or tick (√) the appropriate box

1.0 Background Information

1.1 Name: ……. …….....……

1.2 Sex (Tick one): * ( ) Male ( ) Female

1.3 Year of Study: * (1, 2 est): .....

1.4 Age Group: * (Tick one) ( ) 18-25, ( ) 26 – 34, ( ) 35 – 40, ( ) Above 40

1.5 Course: *.....

1.6 Faculty/College/School*……..

1.7 Institutions: * .....

1.8 My ICT skills level is: * ( ) Beginner ( ) Intermediate ( ) Expert

2.0 Experiences with Ujuzi app

2.1 Device on which you used the app: * ( ) Computer ( ) Smartphone ( ) Tablet ( ) both

2.2 For how long have you been using Ujuzi app? *
( ) Less than a month ( ) One month ( ) Two months ( ) One semester ( ) More than a semester

2.3 What did you use the Ujuzi app for? *
( ) To access micro-learning ( ) to access badges ( ) to browse the features of the app

3.0 Please choose the answer that best represents your experience:

1 = Strongly Disagree, 2 = Disagree, 3= Somewhat Disagree 4 = Neutral, 5= somewhat agree, 6 = Agree, 7= Strongly Agree *

	Feature	1	2	3	4	5
1	I found this app easy to use.					
2	I can use it without written instructions.					
3	I can navigate through the app easily.					
4	The language used in the app is difficult.					
5	The app has adequate help documentation.					
6	The app has adequate help documentation					
7	The app does everything I would expect it to do.					
8	The app is designed for all levels of users.					
9	The app is difficult to work with					
10	Using the app was an enjoyable experience.					
11	The app is unnecessarily complex.					
11	I found the various functions in the app were well integrated.					
12	I think that I would use this app frequently.					
13	I feel very confident using this app.					

4. Please choose the answer that best represents value of the Ujuzi app: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4= Agree, 5= Strongly Agree *

	Feature	1	2	3	4	5
1	The app shortens the time needed to search for content from the Internet					
2	The micro-learning contents are easy to remember					
3	The app leads us to quality content					
4	The app leads to skills improvements					

5	The content from the app is from irresponsible issuers					
6	The idea of the app is irrelevant for me					
7	The app does everything I would expect it to do.					
8	I support the idea behind Ujuzi app development					
9	I would recommend this app to a friend					

5. What could improve the educational aspects of the app? *

.....
.....

6. List the most negative aspects of the Ujuzi app: *

.....
.....

7. List the most positive aspects of the Ujuzi app *

.....
.....

8. What features should we add to improve the app? *

.....
.....

9. Any comments, opinions, suggestions pertaining to Ujuzi app: *

.....
.....
.....

-Thank you so much for your time-

Adopted from https://www.surveymonkey.com/r/si-mobile-app-evaluation (1/9/2019)

ANNEXE 7.1

METHODOLOGICAL RATIONALE OF THE STATISTICAL ANALYSIS

A. Data Suitability

Before factors are extracted, it is required to assess their suitability for factor analysis. The commonly used tests are Kaiser-Meyer-Olkin measure (KMO) of sampling adequacy and Bartlett's test of sphericity (Williams, Onsman, & Brown, 2010). The KMO index ranges from 0 to 1. Although scholars are divided regarding the minimum acceptable value for factor analysis, while some scholars including Williams and Brown (2013) consider the minimum of 0.5 KMO index being satisfactory for EFA, others including (Yong & Pearce, 2013) stress that any value less than .65 is unsuitable for the test. In addition, scholars agree that the significant value for Bartlett's test of sphericity is anything less than .05 written as ($p<.05$).

The table-1 below depicts the results of the suitability test conducted on the data. It reveals that the data is suitable for the factor analysis because both the KMO index value (.883) and Bartlett's test of sphericity, $p<001$ surpass the mandatory limits.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.883
Bartlett's Test of Sphericity	Approx. Chi-Square	4628.704
	df	528
	Sig.	.000

Table 0-1: Results for the suitability test

In addition, Table-2 presents the descriptive statistics of the data: the mean, standard deviation, skewness and kurtosis for each of the items in the scale. The measures describe the extent to which the data are normally distributed. Literature reveals that the acceptable range is up to ±1 for the skewness and up to ±3 for the kurtosis (Krishnan & Ramasamy, 2011). As the result reveals, the kurtosis and skewness statistics for the data are within acceptable ranges. Hence, the data are normally distributed.

Variable	Mean	Std. Dev	Skewness	Kurtosis	Theoretical Range
Reasons for Deployment					
RS1	3.70	1.032	-1.107	1.123	1-5
RS2	3.83	.868	-.848	1.016	1-5
S3	3.94	.866	-.531	-.052	1-5
RS4	3.99	.889	-.849	.685	1-5
RS5	4.01	.834	-.806	1.009	1-5
RS6	4.06	.785	-.690	.723	1-5
Institutional Characteristics					
IN1	3.38	1.146	-.724	-.251	1-5
IN2	3.55	.969	-.754	.186	1-5
IN3	3.71	.897	-.869	1.051	1-5
IN4	3.76	.849	-.914	1.149	1-5
IN5	3.83	.894	-.840	.791	1-5
IN6	3.80	.851	-1.036	1.379	1-5
IN7	3.85	.849	-1.281	2.232	1-5
IN8	3.85	.883	-.999	1.172	1-5
Pedagogical Characteristics					
PE1	3.60	1.035	-.892	.431	1-5
PE2	3.81	.854	-.590	.452	1-5
PE3	3.79	.811	-.331	.043	1-5
PE4	3.92	.745	-.813	1.941	1-5
PE5	3.87	.806	-.643	.584	1-5
PE6	3.95	.774	-1.056	2.607	1-5
User Characteristics					
US1	3.70	.985	-1.158	1.365	1-5
US2	3.81	.826	-.763	.606	1-5
US3	3.88	.846	-.702	.715	1-5
US4	3.77	1.017	-1.040	.988	1-5
US5	3.91	.811	-.826	1.262	1-5
US6	3.95	.759	-.886	1.538	1-5
Technological Characteristics					
TE1	3.87	.997	-1.197	1.434	1-5
TE2	4.09	.771	-.770	.632	1-5
TE3	4.15	.765	-.660	.137	1-5
TE4	4.10	.698	-.450	.169	1-5
TE5	4.15	.707	-.516	.154	1-5
TE6	4.16	.720	-.719	.730	1-5
TE7	4.13	.764	-1.026	2.298	1-5

Table 0-2: Descriptive statistics of the data

B. Exploratory Factor Analysis

As described earlier, EFA is concerned with the reduction of variables into factors. EFA is commonly used to explore observable (measured) variables into factors based on their loadings and variances (Yong & Pearce, 2013). In the next section, we describe how factors were extracted and analysed. Then, we examine whether the factors and the resulting model are a good fit with data.

The procedure starts with factors extraction. Basically, during this stage researchers decide on the extraction method, rotation method, and criteria for extraction. While there are seven methods used to extract factors from respondents' data, these two are commonly used: principal components analysis (PCA) and principal axis factoring (PAF). Particularly, literature asserts that while there exists debate concerning the relative advantage of using either one of the two over the other, some scholars see no practical distinction of the two especially in the case of high reliability of the items as well as when the number of items exceeds 30 (Williams et al., 2010). Similarly, there are two main rotation approaches: orthogonal and oblique. Rotation methods maximize the factor loadings of variables. Each of the rotation approaches contains methods that are applied to data to achieve specific results. The orthogonal rotation methods such as Quartimax and Varimax rotate variables from each other whereas oblique rotation, such as Direct Oblimin and Promax, do not rotate variables (Yong & Pearce, 2013).

In addition, there are various criteria used to reduce a large number of items into factors. They include Kaiser's criteria (eignenvalue>1 rule), parallel analysis and Scree test (Yong & Pearce, 2013). Because each of the aforementioned criteria does not offer absolute value due to some limitations, it is advisable to apply multiple criteria during factor extraction in order to improve the validity of the outputs (Yong & Pearce, 2013). In fact, if Kaiser's criterion is used, only those factors that have eigenvalue above 1 are retained (Abu-Al-Aish, 2014). Also, in order to determine factors to retain by using the Scree test, researchers first determine the point of inflexion within the graph. Then, they extract all points that lie above the identified point (Williams). In addition, parallel analysis involves first generating random eigenvalues based on the number of items being evaluated, the sample size and the number of randomized attempts. Second, the generated values are compared against the corresponding actual eigenvalues in the same order. Finally, only those factors that surpass the randomized values are retained (Williams et al., 2010).

In this work, Principal Axis Factoring and oblique rotation method--Oblimin with Kaiser Normalization methods were used to extract factors from the data. The two methods are highly used and recommended by scholars from various disciplines including education and social sciences. Because of the complexity in the data, three extraction criteria were applied: Kaiser's criterion, Scree plot and Parallel Analysis. The table-3 depicts six factors that are extracted because their eigenvalues are above 1 and have a cumulative variance of 66.33% (the minimum acceptable value is 60%).

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**12.265**	**37.167**	**37.167**	**11.941**	**36.186**	**36.186**
2	**4.094**	**12.406**	**49.573**	**3.816**	**11.564**	**47.751**
3	**2.802**	**8.492**	**58.065**	**2.469**	**7.481**	**55.232**
4	**1.967**	**5.962**	**64.027**	**1.594**	**4.831**	**60.063**
5	**1.502**	**4.552**	**68.578**	**1.166**	**3.533**	**63.596**
6	**1.250**	**3.787**	**72.365**	**.902**	**2.733**	**66.330**
7	.932	2.823	75.188			
8	.792	2.400	77.588			
9	.770	2.332	79.921			
10	.654	1.983	81.903			
11	.512	1.551	83.454			
12	.488	1.479	84.933			
13	.464	1.405	86.337			
14	.406	1.230	87.567			
15	.377	1.142	88.709			
16	.370	1.123	89.832			
17	.358	1.086	90.918			
18	.333	1.011	91.929			
19	.275	.834	92.762			
20	.271	.822	93.584			
21	.253	.766	94.350			
22	.236	.716	95.066			
23	.220	.667	95.733			
24	.209	.634	96.367			
25	.195	.592	96.959			
26	.183	.555	97.515			
27	.170	.516	98.031			
28	.138	.419	98.450			
29	.134	.406	98.856			
30	.129	.392	99.248			
31	.107	.326	99.574			
32	.082	.250	99.823			
33	.058	.177	100.000			

Table 0-3: List of Six factors exceeding eigenvalue of 1

Also, because it is advised to use multiple criteria to ascertain the validity of the output, data were subjected to the Scree plot test. The result reveals the same list of items appears above the point of inflection in the Scree plot as depicted in Figure -1.

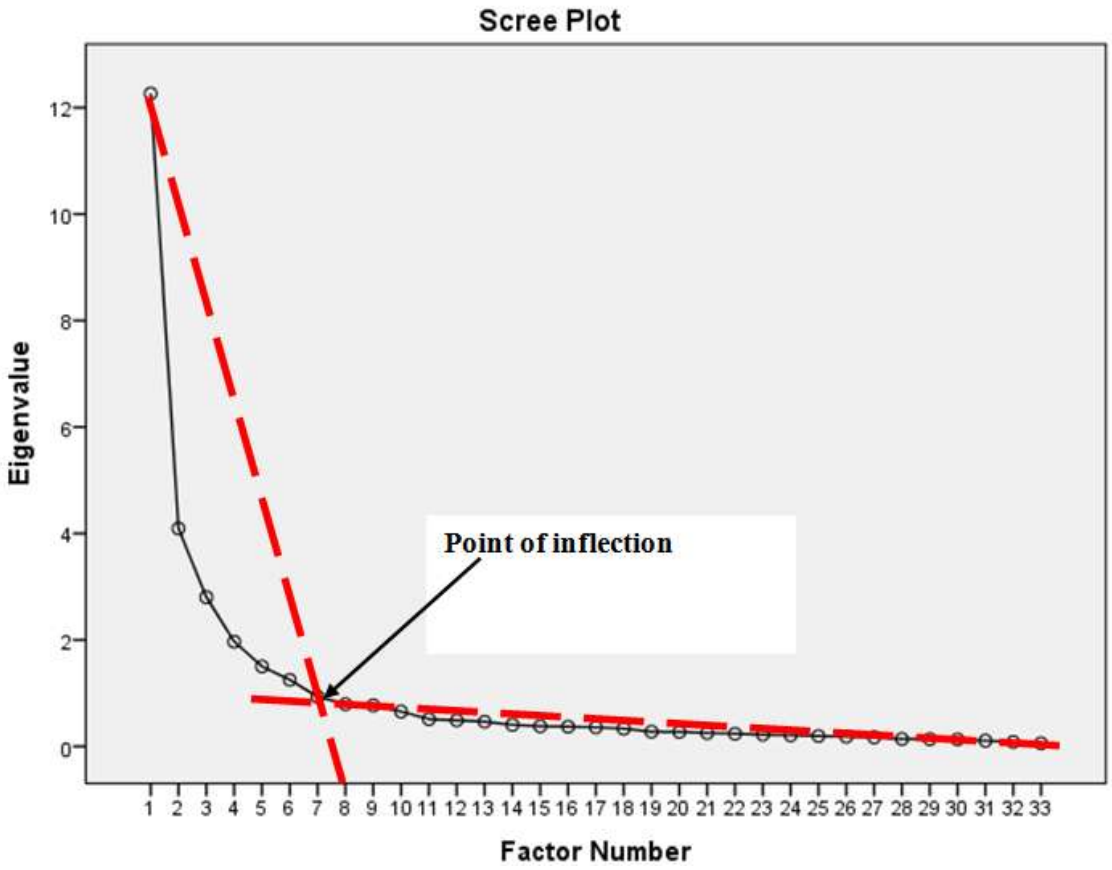


Figure 0-1: Scree plot showing six factors for extraction

Because all the items loadings in the sixth factor are shared with the rest of the factors, the researcher deployed a parallel analysis to add clarity on factors to retain. The outcome of the parallel analysis is shown in table-4. The sixth factor is eliminated because its 1.2500 value falls far away from the corresponding randomized value 1.4835. Because the parallel module is absent in SPSS software, we downloaded the Monte Carlo software specific for this task.

Component Number	Actual eigenvalue	Random Eigenvalue	Decision
1	12.2650	1.9463	keep
2	4.0940	1.8025	keep
3	2.8020	1.7100	keep
4	1.9670	1.6246	keep
5	1.5020	1.5482	keep
6	1.2500	1.4835	Remove
7	0.9320	1.4241	Remove
8	0.7920	1.3652	Remove
9	0.7700	1.3114	Remove
10	0.6540	1.2586	Remove
11	0.5120	1.2116	Remove

Table 0-4: Result of parallel analysis using (Monte Carlo software)

Hence, the outcome of the exploratory factor analysis confirms the factors that were previously identified by scholars and interviews. The tables-5&6 the resulting factors and their corresponding items.

CODE	QN	Observed Variable Name
Reasons for deployment (Factor 1)		
RS2	3.1	Imparting specific skills to learners
RS3		Enhancing retention capacity of the learners]
RS4		Complimenting the existing learning approaches
RS5		Improving the quality of learning experiences
RS6		Micro-learning are the true means for learning anywhere, anytime and any-pace
Technological Characteristics		
TE2	3.2	The features of a learning technology should reflect the need of the users
TE3		The deployed technology should be compatible with my devices (mobile/PC)
TE4		The newly deployed technologies should be compatible with the existing media formats (video, text, audio etc)
TE5		Social interactivity with educators or learners is vital for any learning platform
User Characteristics		
US1	3.3	Skilled learners contribute to the positive output
US2		Learners who are capable of paying for services simplifies the transformation process
US5		Poverty affects the willingness to use the learning platforms
Pedagogical characteristics		
PE3	3.4	The pedagogical belief of the lecturers
PE4		The ability of student to relate online learning and learning strategy
PE5		The pedagogical competence of the lecturer
PE6		Digital literacy of the learner
Institutional characteristics		
IN2	3.5	Budget to support technology deployment
IN3		Policies tailored towards wide acceptance and utilization of online learning
IN4		The ability to commit to a vision of implementing and using online learning in learning
IN6		The leaders' competency in technologies

Table 0-5: Factors with the Associated Items

Pattern Matrix

Item	Reason(s) for deployment	Institutional Characteristics	Pedagogical Characteristics	User Characteristics	Technological Characteristics
RS3	.760				
RS5	.748				
RS4	.736				
RS6	.684				
RS2	.548				
IN5		.888			
IN3		.882			
IN4		.868			
IN6		.848			
IN2		.789			
IN8		.750			
IN7		.744			
IN1		.692			
PE3			.894		
PE2			.878		
PE6			.674		
PE4			.668		
PE1			.655		
PE5			.618		
US2				.740	
US3				.651	
US1				.624	
US4				.560	
US5				.548	
US6				.470	
TE3					.794
TE5					.733
TE2					.710
TE4					.704
TE6					.623
TE1					.620
TE7					.346
RS1	.503				

Table 0-6: Outcome of the exploratory factor analysis

C. Measurement Model

The role of a measurement model is to explain how the observed variables and constructs are related. It is a useful tool used by researchers to examine how the observed (measured) variables combine to explain the hypothesized constructs (Yong & Pearce, 2013). In principle, it is recommended to evaluate the measurement model before they can be used to test the respective hypotheses. Because this is just an exploratory study, the hypothesis testing is beyond the scope of the study. The only goal for creating a measurement model is to test if the model is a good fit. The results help to explain the validity and importance of the extracted factors in micro-learning deployment projects.

Figure-2 shows the measurement model of the study. It depicts variables and their associated factor loadings. To realize the current model, a series of actions were carried out. First, the original model containing all the factors (in Annex 7.3) was created by using AMOS 22 software. Then, the model was tested by using the Maximum Likelihood Estimates extraction method to discover if the model is a good fit. Unfortunately, the original model failed the good-fit test. Hence, all the variables that were poorly correlated are omitted from the model. Also, variables (RS5&RS6 and TE4&TE5) from the same factors were co-varied to each other to improve the model because they had high modification indices.

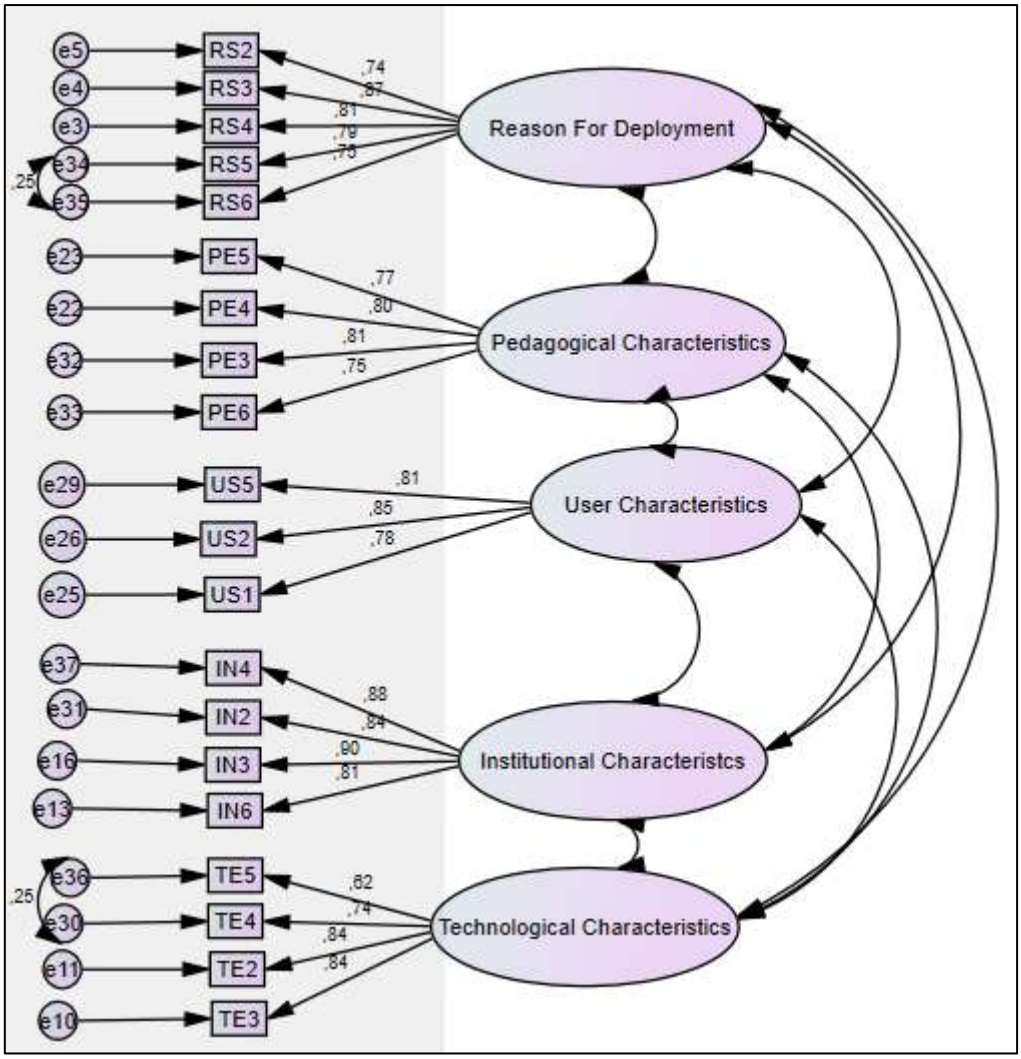


Figure 0-2: Model-fit Indices of the measurement model

The table 7 reveals that the model fit indices of the revised model. The score indicates that the entire model has surpassed all the required measures.

Fit indices	Recommended value	Values obtained
$\chi 2$/d.f	≤3.00	1.56
GFI	≥0.90	0.88
AGFI	≥.80	0.83
NFI	≥0.90	0.89
CFI	≥0.90	0.96
TLI	≥0.90	0.96
RMSEA	≤0.08	0.06

Table 0-7: Model-fit Indices of the measurement model

Also, the measurement model was assessed in terms of factors loading, reliability of measures, convergent as well as discriminant validities. According to Fornell and Larcker (1981), convergent validity is achieved when (1) factor loading is greater than 0.50; (2)

composite reliability is greater than 0.8, and (3) average variance extracted should exceed 0.5.

As shown in Table-8, the results illustrate how the model fits within the required parameters. All the factor loadings are above the required threshold (0.50). The Cronbach's alpha values exceed the .7 threshold. Likewise, the composite reliability values (CR) are above 0.8 except for the user characteristics (.67). Similarly, the average extracted variances (AVE) for all the factors except for user characteristics are above the recommended .5 level, thereby indicating good internal consistency (Abu-Al-Aish, 2014). We decided to keep user characteristics because it has qualified other tests and that the AVE score is not very far from the recommended value. Hence, based on the results, it is evident that the identified factors with their corresponding items represent factors that influence micro-learning deployment in higher education institutions as reflected in the respondents' data.

Construct	Factor Extracted	Cronbach's Alpha	Standardized factor loading	CR	AVE
Reasons for Deployment					
RS2	.55	.897	.74	0.83	0.49
RS3	.76		.87		
RS4	.74		.81		
RS5	.75		.79		
RS6	.68		.75		
Institutional Characteristics					
IN2	.79	.916	.84	0.91	.72
IN3	.88		.90		
IN4	.87		.88		
IN6	.85		.81		
Pedagogical Characteristics					
PE3	.89	.863	.81	.81	.52
PE4	.67		.80		
PE5	.62		.77		
PE6	.67		.75		
User Characteristics					
US1	.62	.847	.78	0.67	0.41
US2	.74		.85		
US5	.55		.81		
Technological Characteristics					
TE2	.71	.855	.84	.83	0.54
TE3	.79		.84		
TE4	.70		.74		
TE5	.73		.62		

Table 0-8: The reliability and convergent indices

ANNEXE 7.2

THE CODING SCHEME

Open Coding	Axial Coding	Focused Coding	Source
Imparting specific skills to learners	Motivation to learn	Learner Readiness	Survey / Factors
Enhancing retention capacity of the learners]			Survey / Factors
Complimenting the existing learning approaches			Survey / Factors
Improving the quality of learning experiences			Survey / Factors
Micro-learning are the true means for learning anywhere, anytime and any-pace			Survey / Factors
Lecturers are capable of owning devices	Ability to pay for devices		Interviews Transcripts
Mixed perception of mobile phone ownership			Interviews Transcripts
positive reaction on mobile ownership to employees students			Interviews Transcripts
Poverty constrains mobile ownership			Interviews Transcripts
Student owns low-budget phones			Interviews Transcripts
Poor students not able to buy devices			Interviews Transcripts
Majority owns mobile phones			Interviews Transcripts
Student loan is the main source of mobile ownership			Interviews Transcripts
Mobile phones are cheaper			Interviews Transcripts
Very few are capable of owning mobile phones			Interviews Transcripts
Families sacrifice for devices			Interviews Transcripts
Families contribute to mobile ownership			Interviews Transcripts
Mixed reaction on mobile ownership through family source			Interviews Transcripts
Positive reaction on bundle for students	Ability to pay for Internet bundle		Interviews Transcripts
Negative reaction on bundle payment for student			Interviews Transcripts
Mixed reaction towards Bundle			Interviews Transcripts
Bundle sharing culture			Interviews Transcripts
Concerns over bundle			Interviews Transcripts
Mobile ownership sacrifices	Ability to pay for services		Interviews Transcripts
Boom halitoshi			Interviews Transcripts
Poverty affects the willingness to use the learning platforms			Survey / Factors
Learners who are capable of paying for services simplifies the transformation process			Survey / Factors
Paying for the sold Micro-learning contents/services			Survey/challenges
mobile technology neutrality	Awareness Issues		Interviews Transcripts
positive perception of mobile			Interviews Transcripts
mixed attitude on ICT and mobile use			Interviews Transcripts
mobile side effects			Interviews Transcripts
Satisfactory understanding of mobile learning			Interviews Transcripts
There exist awareness of mobile technologies and application			Interviews Transcripts
The ability of student to relate online learning and learning strategy			

Slow adoption to new technologies due to lack of trust or awareness			Interviews Transcripts
context switching on the way the mobile phone is used	Digital literacy issue	Digital literacy	Interviews Transcripts
Public schools do not offer ICT knowledge			Interviews Transcripts
skill transfer to students			Interviews Transcripts
Majority of lecturers are digital literate			Interviews Transcripts
Digital literacy of the learner			Survey / Factors
digital literacy influence attitude			Interviews Transcripts
causes for mobile misuse			Interviews Transcripts
Lack of digital literacy			Interviews Transcripts
lack of ICT knowledge to students			Interviews Transcripts
ICT knowledge deployment to students			Interviews Transcripts
ICT knowledge for youth			Interviews Transcripts
Limited understanding of mobile learning			Interviews Transcripts
The need for digital literacy on mobile technologies			Interviews Transcripts
coping strategies for digital illiterates			Interviews Transcripts
Family influence on ICT knowledge			Interviews Transcripts
Informal ICT learning process			Interviews Transcripts
Coping strategy for the ICT illiterate			Interviews Transcripts
The value for ICT knowledge to students			Interviews Transcripts
lack of enabling ICT environment in public schools			Interviews Transcripts
Negative attitude due to lack of digital literacy			Interviews Transcripts
digital literacy helps with responsible use			Interviews Transcripts
Intuitive use of mobile			Interviews Transcripts
Formal basic ICT skills			Interviews Transcripts
Private Schools offers ICT knowledge			Interviews Transcripts
negative perception of mobile technology	Perception	Attitude towards ML	Interviews Transcripts
Positive percept on mobile learning			Interviews Transcripts
Positive perception of students' ability to own Smartphone			Interviews Transcripts
conditional positive perception on mobile deployment			Interviews Transcripts
student mobile use for learning	Perception		Interviews Transcripts
mixed reaction on mobile learning for students			Interviews Transcripts
negative attitudes towards new technology			Interviews Transcripts
Non-ownership due to side effects			Interviews Transcripts
mobile ownership due to social pressure or prestige			Interviews Transcripts
mixed reaction of teachers attitude and support	Attitude to use		
Negative attitude towards online learning for lecturers			
Students attitude is good towards new technology			Interviews Transcripts
lecturers have positive attitudes towards new technologies			Interviews Transcripts
Capacity building on digital literacy	Capacity building on ICT	Institutional Preparedness	Interviews Transcripts
Provide digital literacy and e-learning skills to lecturers			Interviews Transcripts
Lecturers have little knowledge about mobile content preparation			Interviews Transcripts

Availability of capacity building opportunities			Interviews Transcripts
Lack of practical ICT pieces of training in the university			Interviews Transcripts
Challenges with lecturers' ability to use technologies			Interviews Transcripts
Social interactivity with educators or learners is vital for any learning platform	Content development		Survey / Factors
Bundle preference than University Wi-Fi			Interviews Transcripts
The need for the right infrastructure			Interviews Transcripts
lack of enabling ICT infrastructure			Interviews Transcripts
Negative perception of university connectivity			Interviews Transcripts
Limited mobile connectivity			Interviews Transcripts
mixed reaction on mobile connectivity			Interviews Transcripts
connectivity challenges			Interviews Transcripts
mobile smartphones covers for the lack of ICT services			Interviews Transcripts
Mobile phones covers library			Interviews Transcripts
Majority relies on the mobile to access materials	Infrastructure issue		Interviews Transcripts
Mobile phone is essential			Interviews Transcripts
No Wi-Fi services			Interviews Transcripts
ICT structural challenges			Interviews Transcripts
Wi-Fi services available in the library and labs only			Interviews Transcripts
The need for investing in infrastructure and skills			Interviews Transcripts
Establishment of enabling environment			Interviews Transcripts
Availability of relevant infrastructure to support micro-learning			Interviews Transcripts
Positive connectivity at CIVE			Interviews Transcripts
lack of communication and ICT support procedures			Interviews Transcripts
Provide financial support to poor students			Interviews Transcripts
Working with students is crucial on mobile deployment	Availability of support services		Interviews Transcripts
Provide technical support and equipment to the universities			Interviews Transcripts
positive reaction on the availability of clear support procedures			Survey/challenges
The need for policy influence on mobile adoption			Interviews Transcripts
policy enforcement			Interviews Transcripts
Controlled access to mobile phones by students			Interviews Transcripts
enable access to mobile devices	Policy governance		Interviews Transcripts
ICT policy available			Interviews Transcripts
Policy vs implementation gap		Leadership issues	Interviews Transcripts
Existence of necessary institutional policies tailored towards micro-learning			Survey/challenges
Prioritizing ICT initiatives			Interviews Transcripts
ICT initiatives are not prioritized by the university	Priority setting		Interviews Transcripts
Biased support to CIVE			Interviews Transcripts
Limited budget affects universities			Interviews Transcripts
The need for infrastructural experts	Skills adequacy		Interviews Transcripts

Limited number of qualified staff			Interviews Transcripts
Limited number of mobile application developer			Interviews Transcripts
Positive reaction on the ability to manage mobile application			Interviews Transcripts
Lack of specialized mobile developer			Interviews Transcripts
Not aware of mobile content developer			Interviews Transcripts
Limited skills in online teaching			Interviews Transcripts
Skilled learners contribute to the positive output			Survey / Factors
The pedagogical competence of the lecturer			Survey / Factors
Identifying authentic issuers (providers) of the micro-learning services			Survey/challenges
Availability of the competent instructional designers & developers of micro-contents			Survey/challenges
Low motivation leads to high staff turnover	Staff turn over		
the need for skills improvement to all	Skills improvement		Interviews Transcripts
Limited involvement of ICT staff in deciding for the infrastructure	Involvement of users		Interviews Transcripts
The need for involving ICT staff on decision making			Interviews Transcripts
Lack of specialization	Lack of specialization		Interviews Transcripts
The need for long strategic ICT investment			Interviews Transcripts
The need for top management support			Interviews Transcripts
Universities are capable if they decide			Interviews Transcripts
University management support deployments initiatives			Interviews Transcripts
Budget to support technology deployment	leadership issue		Survey / Factors
Policies tailored towards wide acceptance and utilization of online learning			Survey / Factors
The ability to commit to a vision of implementing and using online learning in learning			Survey / Factors
The leaders' competency in technologies			Survey / Factors
University management is very supportive	leadership support		Interviews Transcripts
Lecturers resistance to use technologies	Manage resistance		Interviews Transcripts
Lecturers are the main obstacle to adoption			Interviews Transcripts
Resistance due to digital illiteracy			Interviews Transcripts
the need for controlled mobile access	Managing deployments		Interviews Transcripts
Top management decides for the colleges			Interviews Transcripts
The need for decentralization of ICT services			Interviews Transcripts
Centralized ICT services and servers			Interviews Transcripts
A case for decentralization			Interviews Transcripts
Admins never involved with learning technologies			Interviews Transcripts
The need for a special unit for managing learning technologies			Interviews Transcripts
Mobile is part of students' lives	Motivation to use		Interviews Transcripts
Lack of motivation to ICT staff			Interviews Transcripts
Lack of motivation to use technology			Interviews Transcripts
Need for motivation to lecturers			Interviews Transcripts
The role of the governing bodies	Quality Control (TCU/NACTE)		Interviews Transcripts
The government should work together with			Interviews Transcripts

universities			
the need for systematic change approach	Need for systematic change approach		Interviews Transcripts
The need for mindset change	Need mindset change	Socio-Political Environment	Interviews Transcripts
The need for mindset and attitude change			Interviews Transcripts
Mixed reaction on the ban of mobile in schools	Need national wide recognition		Interviews Transcripts
Supporting the ban in school			Interviews Transcripts
The need for Government subsidy on devices, connectivity, and bundle	National-level policy		Interviews Transcripts
Government should provide loan to all students			Interviews Transcripts
The need for government intervention in ICT			Interviews Transcripts
Existence of necessary national policies tailored towards micro-learning			Survey/challenges
The need for the Government intervention on ICT knowledge in schools			Interviews Transcripts
positive reaction on connectivity in TZ	Access issues	Access issues	Interviews Transcripts
Mobile services can help with limited infrastructure			Interviews Transcripts
Deployed wireless access points to all centers			Interviews Transcripts
Enhancing access to learning resources and activities			Survey / Factors
Locating micro-content(s) offered by the Tanzanian institutions			Survey/challenges
Keeping with the changing pace of the micro-learning content worldwide			Survey/challenges
the need for reading list app	Service availability		Interviews Transcripts
the need for mobile app for library			Interviews Transcripts
the need for online registration apps			Interviews Transcripts
the need for apps that enable free access to learning materials online			Interviews Transcripts
The need for mobile app for registration, payment and online reading materials			Interviews Transcripts
the need for material sharing and chatting App			Interviews Transcripts
Lack of university-owned mobile App			Interviews Transcripts
The need for student results App			Interviews Transcripts
Mixed reaction on university Wi-Fi	Technology readiness		Interviews Transcripts
University Wi-Fi helps with connectivity when in-campus			Interviews Transcripts
Limited bandwidth disconnects Wi-Fi			Interviews Transcripts
Reliance on university Wi-Fi			Interviews Transcripts
OUT have experience in managing systems			Interviews Transcripts
Ability to host and manage services			Interviews Transcripts
ICT technologies are essential for ODL			Interviews Transcripts
The need for relevant mobile technologies	Technology relevancy		Interviews Transcripts
Learning technologies should be easy to use			Survey / Factors

The features of a learning technology should reflect the need of the users			Survey / Factors
The deployed technology should be compatible with my devices (mobile/PC)			Survey / Factors
The newly deployed technologies should be compatible with the existing media formats (video, text, audio, etc)			Survey / Factors
The need for TZ based MOOC	The need for MOOC	Pedagogy	Interviews Transcripts
The pedagogical belief of the lecturers	pedagogy		Survey / Factors
Mixed reaction on blended and fully online			Interviews Transcripts
Positive perception on mobile for blended			Interviews Transcripts

ANNEX 7.3

MODEL VALIDATING: QUESTIONS GUIDE

I am a Ph.D. student at Ghent University in Belgium and an employee of Mzumbe University. I am humbly requesting for your time and effort in providing me with information that will be used in my study on "digital anthropology: Developing a micro-mobile learning deployment model for higher education institutions in Tanzania".

Based on the data we have collected from Mzumbe University, University of Dar Es Salaam, Open University of Tanzania and The University of Dodoma, I have developed a conceptual model that describes the situation at HEIs in Tanzania. Please help me to validate the model by answering only 6 main questions (non-personal) below.
It is my hope that you will be pleased to be part of this journey. I confirm that the data you provide in this study will be used academically and according to ethical standards observed by all the MU and UGent. Both universities demand a high degree of confidentiality and anonymity of the respondents.

With thanks,
Mohamed A. Ghasia
In case of a question, contact: mghasia@mzumbe.ac.tz, +32484262604

3.1 [8]How accurate/realistic and optimal are selected dimensions/constructs/factors (i.e, Pedagogy etc)? *

3.2 Is the model correct and precise in terms of its components' process flow and relationships and structure? (yes/No) and comment (optional) *

3.3 Is the model flexible enough to adapt to the changing context? (yes/No) and comment (optional) *

3.4 Does the model able to meet its intended purpose? (yes/No) and comment (optional) *

3.5 In what ways can we improve the understanding of the model, as well as the model's function and credibility (should there be addition or reduction or amendment)? (yes/No) and comment (optional) *

3.6 Please share any additional comment is any. *

- END -

Thank you so much for contributing to my work, may the God Almighty reward you abundantly.

[8] The personal questions are omitted to save space.