DEVELOPING A FRUGAL INFORMATION SYSTEM TO SUPPORT VERY SMALL ENTERPRISE BUSINESS TRANSACTIONS

By

FREEDOM MTHOBISI KHUBISA

(20910442)

Submitted in fulfilment of the requirements of the Master of Information and Communications Technology Degree

Department of Information Technology, Faculty of Accounting and Informatics,
Durban University of Technology, Durban, South Africa

June 2017

Supervisor: Professor Oludayo. O. Olugbara (PhD)

DECLARATION

I, Freedom Mthobisi Khubisa declare that this dissertation is a representation of my own work both in conception and execution. This work has not been submitted in any form for another degree at any university or institution of higher learning. All information cited from published or unpublished works have been acknowledged.

_____ _____

Student Name Date

Submission approved for examination

_____ _____

Supervisor, Date
Professor Oludayo. O. Olugbara (PhD)

DEDICATION

This dissertation is dedicated to my dear loving mother Thandiwe Khubisa, who took me to school and taught me how to write, never mind that this work was typed-out. It is also dedicated to my father, whom I never got a chance to see and my children in the future, waiting to breathe.

ACKNOWLEDGEMENTS

First and foremost, thank you God. I'm eternally grateful for your many blessings and endless love.

I would like to express my sincere appreciation to my supervisor; mentor; friend; adviser; and a voice of reason Professor Oludayo, O. Olugbara. You always encouraged, motivated, inspired and challenged me to do well since the beginning of my research journey. Certainly, without your expertise and vast research knowledge this study could have been futile. If I never met you, my life would be completely different.

Special thanks to Mishack Nyirenda and Robyn Thompson for their assistance to make this study a success.

My huge appreciation to my mother, Mrs. T.C Khubisa, for her prayers and immense support during tough times.

I acknowledge all my siblings, colleagues, friends and loved ones too numerous to mention that has contributed in one way or the other towards the successful completion of this study, you know who you are, so to all of you I offer my grateful thanks.

The financial assistance of the National Research Foundation (NRF) towards this study is acknowledged. Opinions expressed and conclusions arrived at, are those of the author and are not necessarily to be attributed to the NRF.

"…our time on earth is short and each moment that we are not our truest selves, each moment we pretend to be what we are not, each moment we say what we do not mean because we imagine that is what somebody wants us to say, then we are wasting our time on earth**" - Chimamanda Ngozi Adichie**

Table of Contents

List of Figures

List of Tables

List of Acronyms

API	Application Programming Interface
CP	Comment Percentage
CSS	Cascading Style Sheets
DSR	Design Science Research
DSRM	Design Science Research Methodology
DTI	Department of Trade Industry
GDP	Gross Domestic Product
GUI	Graphical User Interface
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology
IDE	Integrated Development Environment
IoT	Internet of Things
IS	Information System
LINQ	Language-Integrated Query
NFC	Near Field Communication
OCL	Object Constraint Language
RWD	Responsive Web Design
SLOC	Source Lines of Code
SMS	Short Message Service
UI	User Interface
UML	Unified Modelling Language
URL	Universal Resource Locator
VAT	Value Added Tax
VSE	Very Small Enterprise

Abstract

The research reported in this dissertation focuses on the development of a web-based frugal information system (frugal IS) which supports financial management of very small enterprises (VSEs), with a special focus on their business transactions. In most developing countries, VSEs have some significant contributions at various socioeconomic objectives, such as fostering entrepreneurship and improving growth of employment. They represent an income opportunity to retrenched and retired entrepreneurs which is recognised to be crucial to the livelihood of many poor local households and local citizens. In addition, these enterprises have a remarkable role to play in the areas of employment and poverty alleviation. Despite this, the majority of VSEs in developing countries, especially those in rural regions are faced with miscellaneous issues and challenges, which could be ascribed to their resource scarcity. In particular, most VSEs are resource-constrained in terms of knowledge and information resources, financial resources and human resources. What also exacerbates their situation is the fact that the majority of VSEs are still ingrained in their traditional ways of running the business and they are unready to adopt new and innovative working methods. In particular, VSEs are still accustomed to manual paper-based systems which are monotonous, error-prone, highly fragmented and severely inefficient. Unfortunately, all this gravely challenges the growth and development of VSEs.

In this dissertation, a concept of frugal innovation, precisely frugal IS, is applied to distinctively address specific and unique business needs of VEs in developing countries. A methodology that is employed in this research is called design science research methodology (DSRM). The DSRM helped to address the problem of VSEs through design, construction, utilization and evaluation of a web-based frugal IS prototype system. A novel system life cycle model that favours the notion of frugality was employed for the design and development of a web-based frugal IS. The evaluation of the prototype system and its design revealed quite interesting results. The design of a web-based frugal IS prototype system was characterized with low complexity which promoted reusability, maintainability and reliability. The evaluation of usability indicated that the system was fairly simple to use, reliable and effective in terms of managing financial information of VSEs. Based on the general findings of this research, the design and development of a web-based frugal IS for VSEs in developing countries promises to assist VSE owners to assess their profitability, improve their financial management, promote sound economic decisions and help them to avoid business failure.

CHAPTER 1: INTRODUCTION

In South Africa, according to the National Small Business Act (No. 26 of 2003), small businesses are classified into four enterprise categories: micro, very small, small and medium enterprises (Republic of South African, 2003). The terms SMMEs and SMEs are usually used, interchangeably, when collectively referring to these enterprises. Mahembe (2011) realized that, however, there is no consistent use of different enterprise categories of small businesses in many research studies, making comparison difficult and unreliable. Olugbara and Ndhlovu (2014), Delécolle (2011) and Dagdilelis *et al.* (2003) argue that there is relatively limited research that focuses on very small enterprises (VSEs). Liedholm and Mead (2013) stated that there is a need for a more profound understanding of each category of small businesses because the categories that comprise SMEs are vastly distinct from one another.

The object of interest in this dissertation is the category of VSEs which are informal family businesses with one individual who usually plays the owner/manager role (Hishigsuren *et al*., 2014; Dagdilelis *et al.*, 2003). The majority of these enterprises is proliferated in many African countries, more especially in the rural areas. The International Monetary Fund (2015) reported that, in Cameroon, out of the total known size of established enterprises, 74.9% of those are VSEs. Cosh *et al*. (1998) highlighted that VSEs are also pervasive in European countries such as Italy and Spain. According to Delécolle (2011), VSEs represent about 90% of European enterprises. Laporte *et al*. (2015) claimed that the dominant enterprises across the globe are VSEs.

The VSEs are known for specializing in serving valuable products and services that are crucial to the livelihood of many poor local households and local citizens in developing countries (Olugbara and Ndhlovu 2014; Sharma 2012; Laporte *et al*., 2008). Their key characteristics include high labour absorption, superior ability to adapt to rapidly changing trends, effective use of local resources, high elasticity to dynamic business market and customer needs, dynamic in building skills within the service industry, innovative in terms of bringing new or improved products and services (Ndhlovu 2014; Delécolle 2011; Tustin 2003; Bentabet *et al.*, 1998). These characteristics of VSEs impressively contribute to economic improvements and poverty alleviation of many developing nations (Sharma 2012). Thus, these enterprises are considered pivotal from an economic perspective, especially in developing countries (Delécolle 2011; Dagdilelis *et al.*, 2003).

However, despite the pivotal role played by VSEs in enhancing economic growth of emerging and developing economies, there are multifarious issues and challenges that inhibit full growth and development of these enterprises. The issues and challenges that are faced by VSEs include lack of access to finance (Wang 2016; Hishigsuren *et al*., 2014; Chimucheka and Rungani 2013), poor business management (Laporte *et al*., 2015; Quispe *et al*., 2010), poor financial management (Hishigsuren *et al*., 2014; Olugbara and Ndhlovu 2014), lack of marketing strategies (Van Scheers 2011; Lekhanya and Mason 2013), low educational levels (Olugbara and Ndhlovu 2014), lack of knowledge and information (Sharma 2012; Ndhlovu 2014) and limited access to information and communication technology (ICT) (Olugbara and Ndhlovu 2014). These adversities of VSEs could be ascribed to their scarcity of resources, especially for VSEs that are operating in developing countries. Most VSEs in developing countries are resource-constrained in terms of financial resources, human resources, knowledge and information resources, and ICT resources. The literature reveals that lack of resources invariably impedes growth and success of an enterprise (Hussain *et al*., 2012).

Olugbara and Ndhlovu (2014) are of the view that some of the issues and challenges of VSEs are prolonged by their inadequate access to relevant and innovative ICT resources. Ashrafi and Murtaza (2008) highlighted that ICT adoption in developing countries remains a serious challenge because most enterprises excessively rely on foreign products and services. Many ICT solutions which are available to VSEs, especially in emerging markets, are expensive and tailored to meet the needs and resources of enterprise that operate in the developed countries (Kuyoro'Shade *et al*., 2013). Kuyoro'Shade *et al*. (2013) and Ashrafi and Murtaza (2008) conclude that there is a need for enterprise based ICT solutions that are developed specifically for enterprises in developing nations, to address their specific and unique business needs.

In the business world, in particular that of Africa countries where the majority of businesses is highly constrained in terms of resources, frugal innovation is likely a potential change agent that needs to be embraced by entrepreneurs who want to turn their limited resources into an advantage (Bound and Thornton 2012). Frugal innovation is based on the idea of doing more, in a better way, with less (Tan *et al*., 2016). It actually aims to serve low-income customers in developing countries, or emerging markets, who are at the bottom of the pyramid, through developing, under constrained resources, products and services that are of good-quality, affordable, easy to use, and serving their needs (Radjou and Prabhu 2015; Simula *et al*., 2015; Basu *et al*., 2013; Hossain 2013). It is noteworthy that frugal innovation

is not only restricted to products and services; it is also applicable to enterprise processes and marketing methods (Khan 2016; Tiwari 2016). Tan *et al*. (2016) believes that information system (IS) can potentially be a powerful enabler of frugal innovation. In fact, in the IS research community, the notion of frugal innovation has recently brought about a new special category of information systems called frugal IS (Sun *et al*., 2016; Sahay and Walsham 2014; Watson *et al*., 2013). Sahay and Walsham (2014) affirm that frugal IS is a form of frugal innovation. By definition, a frugal IS is "*an information system that is developed and deployed with minimal resources to meet the pre-eminent goal of the client*" (Watson *et al*., 2013; Watson 2013). This dissertation reports on the development of a mobile web-based frugal IS for VSEs.

1.1. **Problem Statement**

Many academic studies that focus on the causes of failure in small businesses have cited poor financial management as one of many fundamental factors that perpetrates failure within the sector of small businesses (Eloho *et al*., 2016; Kambwale and Chisoro 2015; Muchira 2013; Ohachosim *et al*., 2013). However, it is argued that poor financial management is not necessarily what causes small businesses to fail; rather it is the petty business elements such as insufficient skills and *knowledge of financial management practice,* inadequate financial reporting, poor cash flow management, and poor record keeping. In the study of Chelimo and Sopia (2014), it is highlighted that about 60% of small businesses have failed essentially due to poor record keeping. This problem of poor recordkeeping is found to be severe on VSEs (Hishigsuren *et al*., 2014; Ndhlovu 2014; Olugbara and Ndhlovu 2014). Hishigsuren *et al*. (2014) noted that most VSEs have extremely weak record keeping. The majority of VSEs usually keeps little or no records of their business transactions. The diminutive figures of VSEs that keeps and manages records of their business transactions are usually accustomed to manual paper-based systems (Ndhlovu 2014) which are monotonous, error-prone, highly fragmented and inefficient. Unfortunately, what this predicament creates for VSEs, besides internal hindrances, is a huge setback when it comes to accessing finance because financial institutions highly rely on proper business records which assist them in the decision process of granting financial support to small businesses (Ademola *et al*., 2012). According to Hishigsuren *et al*. (2014), VSEs are also disadvantaged to access financial support mainly because of their size, formality, and inability to meet collateral or guarantee conditions.

Shafique *et al*. (2013) posits that most small businesses, including VSEs, are failing to find appropriate solutions for their problems such as record keeping. The existing enterprise ICT solutions do not fit well into the diverse business processes of VSEs (Ndhlovu 2014). Of course, this is primarily caused by the mere fact that many small businesses in developing countries depend on foreign ICT products and services to support their local businesses. The commercial enterprise ICT products and services are not developed distinctively to address specific and unique business needs of enterprises such as VSEs. However, relatively recently, Olugbara and Ndhlovu (2014) developed an IS solution targeting at VSEs with minimal use of resources. Their solution focused mainly on keeping daily sales business transactions of VSEs. This solution was reported to be useful and valuable to VSEs. However, there are still improvements that need to be made in order for this solution to fully support the business processes of VSEs. It is also noteworthy that even Olugbara and Ndhlovu (2014) do not claim completeness in their solution, but rather they call for further research to incorporate functions that are more commanding. Based on this account, this research builds and improves on the solution that is developed by Olugbara and Ndhlovu (2014).

1.2. **Research Aim and Objectives**

The principal aim of this research study is to develop a mobile web-based frugal IS that, in all dimensions, supports the business transactions of VSEs and provides essential enterprise management services. In pursuit of this aim, the following objectives are set:

i) To design a web-based frugal IS for VSEs using UML/OCL specification language.
ii) To evaluate the design complexity of the designed web-based frugal IS for VEs.
iii) To develop an ideal mobile web-based frugal IS that supports VSEs business transactions.
iv) To evaluate the usability of the developed mobile web-based frugal IS in the environment of VSEs.

1.3. **Study Methodology**

The methodology that is applied in this research study is called design science research methodology (DSRM) (Petters *et al*., 2008). The DSRM serves as a framework for research studies based on design science research such as this one. Although DSRM is not the only roadmap for carrying out design science research (DSR) based studies, it suggests a good framework of conducting a DSR in the IS discipline (Petters *et al*., 2008). The goal of DSR is to address the problems of people and businesses through design, construction, utilization, and evaluation of artefacts that seek to transform a current situation to a more desirable one (Kuechler and Vaishnavi 2008; Hevner *et al*., 2004). The DSRM achieves this through a process model consisting of six activities, and these activities are succinctly detailed in Chapter 3, in relation to the research at hand.

1.4. **Significance of the Study**

This study is of significant to the sector of VSEs since it aims to develop a mobile web-based frugal IS that is solely focused and tailored to their business needs. Instead of conforming to the traditional software development life cycle models such as waterfall model, spiral model, agile software model; this study employs a novel life cycle model for web-based application development proposed by Huang *et al*. (2010) which is organically frugal and flexible. The literature reveals that there is a scarcity of research on VSEs (Delécolle, 2011; Dagdilelis *et al*., 2003), therefore, this study bridges this gap and extends the body of knowledge concerning VSEs in developing countries. Many studies in the IS research community, especially the ones targeted towards small businesses, have focused on evaluating the usability of IS, disregarding the evaluation of the design architecture – the blueprint of the system. In this study, the ADVIAN method (Linss and Fried 2010) is explored for measuring the design complexity of the proposed frugal IS, in contrast to employing common object-oriented metrics such as McCabe Cyclomatic Complexity, Source Lines of Code (SLOC) and Comment Percentage (CP) that are often used for assisting system complexity.

It is hoped that the prototype developed in this study will help VSEs improve their financial management, make sound economic decisions, assist VSE entrepreneurs to assess their profitability and cash flow and help them to avoid business failure. The after effects of this study are trusted to advance an enthusiasm for researchers that might be interested in advancing the sector of VSEs in emerging economies. Lastly, this study will serve as a good

example to those who are seeking a better understanding of how DSRM is employed in a DSR oriented-study.

1.5. **Scope of the Study**

The scope of the study is limited to VSEs in the retail sector. Specifically, the focus of this research effort is on the aspect of business management and financial management, in the sector of VSEs with a special attention to business transactions. Other areas that might be worthwhile for effectively enriching the sector of VSEs such as financing strategies, training and development strategies and marketing strategies to name a few, still need to be covered intensively. The artefact that is produced in this research is exclusively limited to the business needs of VSEs who are operating in developing countries; therefore, it was not extended to VSEs in developed countries because of disparities in business requirements.

1.6. **Study Contribution**

Hevner *et al*. (2004) states that "the ultimate assessment for any research is what are the new and interesting contributions?" Firstly, the actual artefact of this study is the contribution itself. Hevner *et al*. (2004) announced that any study that follows DSR paradigm could take care of any issue or problem that has already been addressed; however, the solution that is presented in that study should be more effective and/or efficient than the current one. The MobiSalesX prototype system builds and improves on the solution of Olugbara and Ndhlovu (2014) and solves known and some unknown problems of VSEs in a more effective and efficient way.

The IS solution that was developed by Olugbara and Ndhlovu (2014) employed a native development approach and adopted a rich client-server architectural design. Consequently, the solution was then explored on the mobile phones of VSEs, in particular the ones that were running on the Android platform. However, many VSEs who owned mobile devices with low device capabilities and running on different platform were constrained because the solution was platform-specific.

The MobiSalesX system is cross-platform and cross-browser compatible, which means that it can deliver its services to a wider audience of VSEs. This contribution was achieved at the design-level, through employing a web-based client-server architectural design and following a web-based system development. This proved to be frugal in terms of development cost and time because it required no development of additional components

such as update handling, session handling, and synchronisation (Gruhn and Köhler 2006). The new commanding features of MobiSalesX system are highly valued with respect to their capability of increasing profitability, growth, and success in the business of VSEs. The MobiSalesX system reflects the features of a good record keeping system such as simple to use, easy to understand, reliable, accurate, consistent and designed to provide information on a timely basis (Ademola *et al*., 2012). The function that helps VSEs to manage their business cash flow is clearly supported in MobiSalesX system. The improvements which are manifested in this study are regarded important and relevant to DSR which is sometimes called "improvement research" (Vaishnavi and Kuechler 2013).

This research study also contributes towards promoting frugal innovation in developing economies where people are suffering from shortage of nearly all resources. Watson (2013) states that Africa has a great potential to enhance the living standards through IS innovation. The classification of such innovative information system is referred to as frugal IS (Watson *et al*., 2013), which is the output of this study. The other contributions that are realized in this research study are as follows:

i) Exploring the ADVIAN method for assessing the complexity of an enterprise architecture design is a distinct contribution.
ii) Using a novel life cycle model to develop a mobile web-based frugal IS for VSEs is regarded as a vital contribution.
iii) The development of MobiSalesX system fosters mobile enterprises at the bottom of the pyramid.

1.7. **Study Outline**

This dissertation consists of six chapters. Chapter 1 provides the introductory part of this dissertation, which covers a brief background of VSEs and their importance in the economic advancement of emerging economies. In addition, the problem statement, the research aim and objectives, the research methodology, the scope of the study, and the significance of the study of this research are precisely described in this chapter. Chapter 2 presents a comprehensive review of the existing literature concerning VSEs. This chapter covers heading such as development of VSEs, issues and challenges of VSEs in developing countries, barriers to ICT adoption by VSEs, frugal innovation for VSEs in developing countries, mobile technologies in VSEs, mobile systems architectures, and development approaches for mobile systems. Chapter 3 discusses the research methodology of this research study. Precisely, it lucidly deliberates on the approach that was followed and succinctly unpacks the different concepts that were explored to actualize the solution to the business problem of VSEs. Chapter 4 presents a detailed process of development of the prototype that is proposed as a solution for VSEs. In addition, this chapter provides a demonstration of the developed mobile web-based frugal IS prototype. Chapter 5 discusses the evaluation of the implemented artefact and its design and provides the analysis of the results. Chapter 6 presents a conclusion of the overall research study. The limitations and possible future research work are also presented.

CHAPTER 2: LITERATURE REVIEW

To put this study in proper context, it is of paramount importance to review the literature that exists on VSEs. Specifically, this chapter provides a comprehensive review of the nature, characteristics and contributions of VSEs. Furthermore, it distinctly discusses the issues and challenges of VSEs with regard to finance, management, marketing, knowledge and information, and ICT. A close look at barriers that promotes slow penetration of ICT amongst VSEs is also provided. It is also highly relevant to include a review of frugal innovation because this relatively recent philosophy is being exploited in this dissertation for addressing some of the issues and challenges of VSEs. The review of system architectures and different mobile solution development approaches are also studied in this chapter. The aim of the entire review is to systematically guide the process of solving the research problem and achieving the objectives which are outlined in the previous chapter. Moreover, this literature serves as a tool for searching relevant knowledge within the research domains.

This chapter covers eight germane sections. Section 2.1 discusses the development of VSEs, precisely focusing on the nature, characteristics and contributions of VSEs. Section 2.2 elaborates on issues and challenges that are faced by VSEs in developing countries. Section 2.3 details barriers that are hindering VSEs from adopting ICT solutions. Section 2.4 explains frugal innovation and its characteristics; with an interest in frugal IS as a possible intervention for VSEs. Section 2.5 covers the penetration of mobile phone technology in VSEs and reviews existing mobile solutions to small businesses, including VSEs, paying more attention to their strengths and weaknesses. Section 2.6 provides a review of four mobile system architectures, exactly for client and server architecture, with an objective of identifying the one that favours frugal IS. Section 2.7 discusses the different approaches to the development of mobile enabled solutions with an intention of selecting the most appropriate development approach for this dissertation. Section 2.8 concludes by giving a summary of the chapter.

2.1. **Development of Very Small Enterprises (VSEs)**

In South Africa, according to the National Small Business Act (No. 26 of 2003), small businesses are classified into four categories: micro, very small, small and medium enterprises (Gono *et al*., 2013; Republic of South Africa 2003). The terms SMMEs and SMEs are usually used, interchangeably, to collectively refer to these enterprises. In the past decade, there has been a multitude of academic research which has been carried out on small businesses and most of it has viewed SMEs as a homogenous unit. However, policymakers; government leaders; economists; and academic researchers such as Psychogios *et al*.(2016), Ahmad and Alam (2015), Lekhanya (2010), Van de Vrande *et al*. (2009), Blowfield and Murray (2008), Gavian *et al*. (2002) and Kesper (2001) have recently maintained a common assertion that SMEs are not homogenous. One key reason that fails SMEs to be considered as a homogeneous group is the fact that they are constituted by different enterprise categories (or sub-sectors) which are profoundly diverse in many dimensions: (a) they have diverse characteristics and needs; (b) they operate in diverse geographical situations and; (c) they face diverse constraints and challenges. In addition, the different enterprise categories that comprise small businesses represent different types of entrepreneurship (Blowfield and Murray, 2008). Thus, studying small businesses as a homogenous unit has a tendency of overlooking the heterogeneity and diversity that exist in this sector.

Mahembe (2011) realized that there is no consistent use of different categories of small businesses in many research studies, making comparison difficult and unreliable. Olugbara and Ndhlovu (2014), Delécolle (2011) and Dagdilelis *et al.* (2003) argue that there is relatively limited research which focuses mainly on very small enterprises (VSEs). In the South African context, the studies that have shown interest in VSEs such as McGrath *et al*. (2005) and Tustin (2003) have also included micro enterprises. While such studies have provided vital knowledge of certain business aspects of both enterprise categories; the need for a more profound understanding of each category of small businesses remains (Liedholm and Mead 2013). As we know, there is no one size fits all solution in this world that can address all issues and challenges that are faced by small businesses. Therefore, as suggested by Kesper (2001), the assistance that is currently provided to small businesses, in particular to South African SMEs needs to be replaced with a fine-tuned set of interventions. However, in order to develop a set of adequate interventions, there is a need to first get down to the level of each targeted enterprise category - to the place where they operate, and comprehensively

obtain a thorough understanding of their diverse characteristics, needs, challenges and opportunities. “Policies, incentives and support structures need to be designed with the understanding that the businesses that fall within the broad ‘SME’ category differ vastly from one another” (SBP 2014). This understanding would significantly aid to yield a best suitable scheme that speaks to the preeminent needs of a specific enterprise category such as VSEs.

2.1.1. **Definition of VSEs**

To begin with, there is no universally accepted definition of VSEs (O'Connor *et al*., 2010; Desharnais *et al.*, 2007). Different countries and institutions adopt different definitions of VSEs which substantially differs in terms of size (Desharnais *et al.*, 2007). For instance, in France, VSEs are defined as independent enterprises that can employ less than ten employees (Bentabet *et al.*, 1998), while in Botswana VSEs are regarded as enterprises that have five or less employees including the owner (Hinton *et al*., 2006). In South Africa, VSEs are defined as informal enterprises that can have up to twenty or fewer employees (DTI 2008), while in Ghana VSEs are enterprises with at least six employees but no more than nine (Dalitso and Peter, 2000). Despite the lack of consensus on the definition of VSEs, Delecolle (2011) explains that VSEs can be generally defined through five essential criteria: dimensional (exceptionally restricted employees), management (centralized in the owner’s hand), functional (the owner/manager decides on strategies), informative (rich but informal information system), and strategic (strategy is intuitive and rarely formalized). These enterprises are different from micro-enterprises who usually employ no more than five employees and have no access to technology (ILDP 2014). However, to avoid misconstruction about the definition of VSEs in discussion and to enable effective comparison of research efforts on VSEs that are and yet to be conducted; this study conforms to the definition outlined by the Department of Trade Industry of South Africa.

2.1.2. **Nature, Characteristics and Contributions of VSEs**

Most VSEs are informal family businesses with one individual who usually plays the owner/manager role (Hishigsuren *et al*., 2014; Dagdilelis *et al.*, 2003). They are generally informal or semi-formal businesses that often operate as sole proprietors or partnerships (Olugbara and Ndhlovu 2014). In most emerging and developing countries, VSEs are initiated by individuals who have had an intensive involvement in the business market (McGrath *et al*., 2005) and left the job for various reasons such as retrenchment or retirement with the motivation of exploiting a new idea or a longing to take after an entrepreneurial path.

In places where there are few better options for a living, especially in countries with low per capita income, VSEs are pursued as means to provide survival tools. The majority of these enterprises are proliferated in many African countries, especially in the rural areas. However, Cosh *et al*. (1998) highlighted that VSEs are also pervasive in European countries such as Italy and Spain. According to Delecolle (2011) VSEs represent about 90% of European enterprises. Laporte *et al*. (2015) claimed that the dominant enterprises across the globe are VSEs.

VSEs are known for specializing in serving valuable products and services, at community or village level, which are crucial to the livelihood of many poor local households and local citizens (Sharma 2012; Laporte *et al*., 2008). The paramount benefits that customers gain by patronizing VSEs are that they pay for value added tax (VAT) on the cost of VSEs (if the VSEs is not registered for VAT) not on the value added by VSEs and they get products and services at cheaper prices. The role of VSEs in service industry is significant, especially in developing countries. Majority of VSEs, particularly in the rural areas, are engaged in small retail shops, vending activities, agricultural activities and livestock production (Sharma 2012). In the National Small Business Act (No. 26 of 2003) it is clear that VSEs are involved in diverse sectors including agriculture, construction, manufacturing, wholesale trade and catering (Republic of South Africa 2003). There are also VSEs who are engaged in software development and they are discussed in the studies of Laporte *et al*. (2015), Quispe *et al*. (2010) and Habra *et al*. (2008). It is documented that VSEs tend to prevail magnificently in sectors where economies of scale are not critical and/or where there is little capital intensiveness. The key characteristics of VSEs include high labour absorption, superior ability to adapt to rapidly changing trends, effective use of local resources, high elasticity to dynamic business market and customer needs, dynamic in building skills within the service industry, innovative in terms of bringing new or improved products or services, and high creation of jobs (Olugbara and Ndhlovu 2014; Ndhlovu 2014; Delecolle 2011; Tustin 2003; Bentabet *et al.*, 1998).

The study of Cosh *et al.* (1998) highlighted that VSEs have a great potential for employment growth, especially in developing countries. They represent an income opportunity to retrench and retired local entrepreneurs, therefore, providing a much needed income to poor households. Their significance in employment as well as poverty alleviation is crucial (Sharma 2012). Hence, VSEs are considered pivotal from an economic perspective (Delécolle 2011; Dagdilelis *et al.*, 2003). In most developing countries, these enterprises

constitute an important factor in the economic landscape. The creation of employment fostered by VSEs enhances economic growth of emerging and developing economies. Ndhlovu (2014) stated that VSEs also have a vital contribution to the gross domestic product (GDP) of most developing countries and their contribution speaks to the economic wellbeing of many countries. Hence, it is no wonder why Delécolle (2011) regard VSEs as an economic decision unit. Table 1 below demonstrates the numbers of active South African VSEs and their contribution towards GDP and employment.

Table 2.1: The contribution of South African VSEs to the economy (Adopted from Mahembe 2011)

Percentage	Survivalist	Micro(0)	Micro	Very Small	Small Enterprise	Medium Enterprise	Large
Number of firms	19.6	31.3	19.8	20.5	6.8	1.3	0.7
Employment	2.2	3.5	6.5	13	15.7	13	46.1
GDP	5.8			13.9		15	65.2

In 2007, out of the known size of economically active enterprises in South Africa, 46% of those were VSEs (DTI 2008). In the past years, these enterprises have shown tremendous growth and this can be realized on the above given table. Although the figures are not the definite reflection of the contributions that are made by VSEs because a number of these enterprises are not officially registered or recognized by legislation (Olugbara and Ndhlovu 2014; Sharma 2012) but what this exhibits is the remarkable contributions that VSEs are making in the areas of employment and economic development.

Moreover, VSEs have a special contribution to make towards the development and accumulation of skills within the production system, particularly in the service industry (Bentabet *et al.*, 1998). It is documented that VSE owner/manager who possess great skills and knowledge of service industry, through previous work experience, are involved in the transfer of skills and knowledge to the young potential VSE entrepreneurs within the enterprise. This practice is more common in African countries, and more immediate relevant to South Africa. In the study of McGrath *et al*. (2005), it was found that 77% of South African VSE owner/manager were trainers within their enterprise. It is noteworthy that VSEs do not only contribute to youth development but they are also involved in adult development. Dagdilelis *et al.* (2003) revealed that VSEs also employ adults as well. According to Bentabet *et al.* (1998) the acquisition and upgrade of technical skills is one of the priority skill transfers within VSEs. Technical skills, in particular, are recognised to be important for increasing

innovative activities, and innovation is a major player in economic growth. The transfer of knowledge and skills is one of the pillars that foster enterprise development and success, which in turn impacts the economy. Sharma (2012) reports that in Nepal, South Asia, there are a number of initiatives which are aimed at creating additional employment and income opportunities through providing business knowledge and skills and other economical driven assistance to poor and disadvantage individuals. He further highlights that most preference has been directed mainly to individuals that wish to establish VSEs. It can be debated that preference has been given to VSEs because of their propitiousness and strength in economic development.

The significance of VSEs in the socio-economic development cannot be deserted. Small businesses such as VSEs, who are agile and responsive to changes in the marketplace, hold a prominent advantage in the competitive market. Liedholm and Mead (2013) maintain that each category within the broad classification of small businesses has its own distinctive contribution in the process of development. Therefore, it can be inferred that VSEs are crucial in improving the economy of developing countries. In addition, they are a special instrument for combating the excruciating issue of unemployment which barricades many African countries. Moreover, VSEs represent a good initial entry point for low-skilled young people to enter into the labour market (Bentabet *et al.*, 1998). However, despite this luminous significance and contributions of VSEs to the socio-economic landscape of developing countries, there are still numerous issues and challenges that inhibit the effective development and growth of these enterprises.

2.2. **Issues and Challenges of VSEs in Developing Countries**

There are serious concerns about the issues and challenges that stifle VSEs from flourishing. As much as VSEs are known for creating jobs opportunities in developing nations, numerous reports reveal that they also lose a huge number of jobs. Several research studies have reported that majority of small businesses, including VSEs, often collapse within the first five years of operation (Tobora 2015; Nyanga *et al*., 2012; Khalique *et al*., 2011). In developing countries such as South Africa, the failure rate of new small businesses is estimated at approximately 75% (Olawale and Garwe 2010). Wolmarans and Meintjes (2015) revealed that this is the highest failure rate in the world. The review of the literature has shown that out of the five available growth stages of small businesses (inception, survival, expansion, growth and maturity); VSEs are often unsuccessful to advance beyond the inception and

survival phase (Ndhlovu 2014). There are multifarious issues and challenges that inhibit the development of VSEs such as poor management, deficient marketing strategies, limited access to innovate and relevant information and communication technology, inadequate infrastructure, restricting registration policies and government regulations and lack of financial support (Olugbara and Ndhlovu 2014; Sharma 2012). In this section issues and challenges of VSEs pertaining to finance, management, marketing, knowledge and information, and technology are discussed distinctly.

2.2.1. **Finance**

The academic literature copiously highlights that the key challenge which is faced by small businesses, especially in developing countries, is obtaining financial support or accessing finance (Wang 2016; Chimucheka and Rungani 2013; Ackah and Vuvor 2011; Kung'u 2011). According to the World Bank Ghana Office (2016), in 71% of African countries, small businesses cited access to finance as the major hindrance. Mbedzi (2011) pointed out that the problem of lack of access to finance does not only affect small businesses in developing countries but it is worldwide issue and small businesses in developed countries are also challenged in this regard. The study of Beck (2007) highlighted that, specifically in developing countries, there are more financing obstacles that are faced by other enterprise categories in the spectrum of small businesses than medium and large enterprises. This assertion indirectly favour the findings of Makina *et al*. (2015) which return that the more the enterprise grows, the easier it becomes to access finance.

According to Herrington *et al*. (2009) most South African small businesses lack financial support. This inaccessibility to finance makes it difficult for these enterprises to grow and prosper. It is recognized that the situation is worse for the informal sector. Agwa-Ejon and Mbohwa (2015) posit that South African entrepreneurs are often deprived financial support because of their informality. However, formality is not the only factor that divests small businesses; there are other factors that also contribute to this difficulty of accessing finance, especially for VSEs. According to Hishigsuren *et al*. (2014) VSEs are disregarded to access financial support mainly because of their size, formality, inability to meet collateral, or guarantee conditions. Sjauw-Koen-Fa and Vereijken (2005) noted that formal financial institutions usually avoid VSEs because they are perceived as too risky to serve and associated with higher costs. As a result, most VSEs in developing countries are financially excluded. VSEs in developing countries often rely on their own saving capacities, relatives,

friends or family members to finance their business. Even the available financial products or services do not favour them (Abor and Quartey 2010). In spite of the numerous funding programmes that have been designed as a form of intervention, particularly in South Africa, to support and facilitate the development of financial services of small businesses, it is observed that most VSEs especially those from rural areas are not aware of these support systems due to lack of information (Mpiti and Rambe 2016; Agwa-Ejon and Mbohwa 2015; Chimucheka and Rungani 2013). Furthermore, very few of these programmes are aimed at assisting VSEs.

Therefore, it is clear that VSEs are faced with severe financial constraints and without adequate financial resources to meet their needs; it will remain a challenge for these enterprises to be successful. According to Hishigsuren *et al*. (2014) the financial needs of VSEs are not as sophisticated as that of medium or large enterprises. The financial products or services that are aimed at assisting VSEs must take into cognisance their local needs because different categories of small businesses differ vastly. In addition, microfinance institutions and other alternative institutions such as the ones that are described by Sjauw-Koen-Fa and Vereijken (2005), need to adapt and revise their products or services to tailor to the needs of VSEs.

2.2.2. **Management**

The growth and development of VSEs is also challenged by poor business management. According to Quispe *et al*. (2010) VSEs have high informality in terms of planning, organizing, directing, monitoring and controlling their business. Majority of VSEs, especially those that are driven by rural entrepreneurs, have little information and experience in the field of management. The aspect of management in VSEs is greatly informal and involves less documentation (Laporte *et al*., 2015; Hishigsuren *et al*., 2014). A plethora of academic literature has cited poor management as one of many constraints that are hindering small businesses growth and survival (Taiwo *et al*., 2016; Fatoki 2014; Okpara 2011). According to Mahembe (2011) the prime cause of poor management in small businesses is lack of adequate training and education.

Olugbara and Ndhlovu (2014) noted that VSEs have low education. The lack of education and high illiteracy in the sector of VSEs makes it almost impossible for these enterprises to realize growth. Imedashvili *et al*. (2013) explain that the low level of education in rural areas has an implication on rural entrepreneurs. According to Papulová and Mokroš

(2007), VSE owner/managers need to gain basic skills and knowledge of managerial functions at the initial stages of running their businesses. However, there is a serious intervention needed in the aspect of financial management as far as VSEs are concerned. Even research efforts that are focused on the aspect of management in small businesses have emphasised more on financial management (Mazzarol *et al*. (2015), Zapata *et al*. (2014), Jindrichovska (2013) and Bestvinová *et al*.(2012)) simply because it plays a crucial function in business management as a whole (Salikin *et al*., 2014).

While Tustin (2003) argued that some VSE owner/manager do have skills of keeping their business transactions. Hishigsuren *et al*. (2014) on the other hand identified that most VSEs keep weak records of their business transactions. Most, if not all, VSE accounts and documentations are usually inadequate, inaccurate and unreliable (Hishigsuren *et al*., 2014; Olugbara and Ndhlovu 2014). In fact, their business records are often unprofessional with no element of knowledge or recording pattern that could be traced. According to Jindrichovska (2013) this could be caused by lack of knowledge or interest in recording business transactions. On the other hand, Olugbara and Ndhlovu (2014) attributes this deficiency to the ad-hoc business processes and practices that are adopted by VSEs. In the findings of Quispe *et al*., (2010), it was uncovered that the ad-hoc processes of VSEs, in particular those that are engaged in software development, led them to requirement management issues such as loss of requirements. Ndhlovu (2014) highlights that the diminutive figures of VSEs that keeps and manages records of their business are usually accustomed to manual paper-based systems. Nevertheless, even with manual paper-based systems, VSEs still struggle to distinguish business capital from personal cash (Adisa *et al*., 2014; Esselaar *et al*., 2007). Most of them believe that their business is too small to have separate accounts. Unfortunately, what this creates is a huge setback which harms the core of their business because when household crisis arises, VSEs immediately transfer the capital generated from business sales or services to fulfil household or other private desires (Falkena *et al*., 2002). This type of poor financial management subsequently results in VSEs experiencing cash flow and liquidity problems (Mazzarol *et al*., 2015; Ndhlovu 2014). The literature points out that the lack of proper financial management creates numerous business problems.

Consequently, VSEs need to strategically manage every aspect of their enterprise, especially the financial aspect, in order to attain smooth growth and sustainability. Managing their enterprise strategically would significantly improve their economic and financial results, increase their competitiveness and strengthens their market position (Svetlana and Alexei

2012). However, to realize this there should be an ideal intervention made by governments and relevant agencies because VSEs cannot afford the cost of participating in formal management trainings or visit consulting firms (Abor and Quartey 2010). The governments and relevant agencies in developing economies need to ensure the availability of sound entrepreneurship education programmes and business management trainings to all VSEs, especially the ones that operate in rural areas, in order to manifest a sustainable economic growth. Additionally, they should also encourage VSE entrepreneurs to further their education because it has been discovered that higher education levels aids in management and marketing capabilities.

2.2.3. **Marketing**

According to Marjanova and Stojanovski (2012) the high failure rates of small businesses, including VSEs is connected with weaknesses in financial management and marketing. Van Scheers (2011) and Dockel and Ligthelm (2002) points out that very little marketing is done by small businesses in South Africa. Marketing in small businesses is usually based on their inherent characteristics such as size, personal contact network, resource constraints, strong sales focus, and strong awareness of certain aspects of formal marketing (Marjanova and Stojanovski 2012). VSEs face a critical challenge when it comes to marketing their products and services because of scarce financial resources which limits their financial spending for sales promotion and advertising. Gilmore *et al*. (2001) acknowledges that small businesses cannot do conventional marketing because of resource limitations. The marketing of VSEs is often haphazard and informal. They focus more on sales over marketing because they believe that this yields immediate results. Usually, there are no enough funds and time reserved by VSE owner/manager for marketing because they lack the understanding of the intrinsic benefits that marketing could bring to their enterprises (Lekhanya 2010). Some VSEs even perceive marketing to be costly and time consuming. According to Kumar and Dangi (2013), transportation, warehousing, underdeveloped people and underdeveloped market, inadequate media coverage, many languages, low level of literacy and seasonal demand are some of the intrinsic marketing challenges faced by VSEs in the rural areas.

Lekhanya (2010) maintains that lack of marketing and poor marketing devastates many enterprises in the rural and under-developed areas of many developing countries. The assumption is that if potential customers are not aware of products or services no one will do business with the VSE. Brink *et al*. (2003) highlight that marketing factors such as poor

products and services, poor location, misreading customer trends and needs, insufficient marketing, and misreading the market impacts on the success of small businesses. The development of marketing skills and knowledge within VSE sector is essential. VSEs in developing countries need to employ effective marketing strategies that are concentrated on increasing sales while ensuring that the needs of the customers are satisfied within their limited resources. Sharma *et al*. (2013) suggest that VSEs owner/manager need to come up with new advertising strategies that are cost-effective and simple enough to be understood by the rural people. Furthermore, given the scarcity of resources within VSEs, marketing tools suitable for utilization by VSEs must be welcomed if they can be efficient and effective in enhancing marketing practice in this sector.

2.2.4. **Knowledge and Information**

Sharma (2012) identified lack of knowledge and information as another challenge that is faced by many VSEs. A similar argument is advanced by Ndhlovu (2014) who argues that VSEs lack essential information and knowledge, which they need in order to advance their business. Due to this scarcity, most VSEs in African countries are still handicapped to participate in the knowledge-based economy (Olugbara and Ndhlovu 2014). A knowledge-based economy by definition is "the one that has an economic incentive and institutional regime that stimulates the acquisition, creation, dissemination, and use of knowledge and information to improve its growth and welfare, as well as effective systems of education and skills, ICT, research and development, and innovation" (ADB 2014). Needless to say, knowledge and information are at the heart of any knowledge-based economy. In spite of the fact that small businesses are envisaged to be the drivers of change in the knowledge-based economy (Brinkley 2008), but in the case of VSEs specifically, there is still a critical gap that needs to be addressed following the findings which disclose that these enterprises are also lagging in terms of training, research and development (Ndhlovu 2014; McGrath *et al*., 2005; Bentabet *et al.*, 1998). These essentials which VSEs are struggling with are somewhat related to the building of a knowledge-based economy as well.

In an enterprise, knowledge and information may originate from various sources which include IS, reports, customers and suppliers, internet, and internal documentation, just to name a few (Mocanu *et al*., 2010). Foluso *et al*. (2014) stressed the importance of ICTs for development of knowledge-based economy, especially for businesses in developing countries. According to Salem (2014) research, technological advancement, and highly

skilled workforce translate to productivity gains and, in turn, boost economic growth and development. Therefore, if anything, this points out that there is still a need for critical training, research and development in the sector of VSEs as a force for stimulating their participation in knowledge economy. VSEs also need to realize that ICT is an imperative enabler for a knowledge based economy.

2.2.5. **Information and Communication Technology (ICT)**

Olugbara and Ndhlovu (2014) pointed out that VSEs are limited when it comes to access to ICT. In fact, some VSEs are not even aware of technological developments, especially those that operate in the rural areas. Due to low educational levels and lack of ICT knowledge and skills amongst VSEs, they often perceive the integration of ICT to their business as risky, costly, time consuming and complex (Ndhlovu 2014; Qarri 2011). Dagdilelis *et al.* (2003) revealed that there are VSEs who believe that ICT does not concern them. It is also noted that for many VSEs, especially in developing countries, ICT is not yet a priority (Ogunsola 2008). Most VSEs still prefer to use the traditional business methods to run their enterprise and they appear to be unready to adopt new and innovative working methods. Unfortunately, the traditional methods which seem to be ideal for most VSEs have many setbacks and they musk the potential benefits that ICT could bring to their business. On the other hand, there are a few of VSEs who are exploiting ICT but in many cases their purchase does not involve proper planning (Levy and Powell 2004) due to their lack of ICT knowledge. Thus, most systems, such as mobile phones that are purchased by VSEs do not adequately support their business strategies and processes and for this reason they end up being redundant. In addition, due to their financial constraints, they often choose the cheapest systems which are inadequate to satisfy their business needs.

Ndhlovu (2014) advocates that VSEs need to incorporate ICT as part of their core business strategies so as to enhance their productivity and enable effectiveness and efficiency in their business. Dagdilelis *et al.* (2003) advise that in an enterprise such as VSEs the successful use of ICT must be dealt with in a particular way. Therefore, it is prudent to investigate the barriers that inhibit VSEs from ICT adoption as this would help in understanding the manner in which ICT should be delivered to VSEs.

2.3. **Barriers to ICT adoption by VSEs**

There are numerous ICT solutions that are available in the market for small businesses, including VSEs, that promises to deliver tremendous benefits into their business. The perceived benefits of adopting ICT solutions in small businesses have been covered extensively in the academic literature. They include increasing performance and productivity (Kuyoro'Shade *et al*., 2013), improving business related communications (Mbuyisa and Leonard 2015; Parida *et al*., 2010), enhancing customer services (Afolayan *et al*., 2015), improving information and knowledge management (Ongori and Migiro 2010) and providing affordable ways of advertising and marketing (White *et al*., 2014). Unfortunately, there are a number of factors that hinder small businesses, especially in developing countries, to reap some of these benefits of ICT solutions, hence, the slow adoption rate (Cant *et al*., 2015; Irefin *et al*., 2012; Nejadirani *et al*., 2011; Alam and Noor 2009). The factors that relate to the slow adoption of ICT solutions usually vary across different sectors and countries. In most studies they are broadly categorized as internal barriers and external barriers (Manuere *et al*., 2012; Ashrafi and Murtaza 2008; Kapurubandara and Lawson 2006). The internal barriers exist within an enterprise and they include lack of resources, limited ICT literacy, owner/manager characteristics, cost and return on investment and enterprise characteristics. The external barriers exist outside the enterprise and they include poor infrastructure facilities, unfavourable policies and legal frameworks, and social and legal and regulatory. Kapurubandara and Lawson (2006) argued that the internal barriers can be addressed by the enterprise itself and external barriers need government interventions or collaboration among small businesses.

The limited access to ICT solutions amongst VSEs is greatly caused by their limited resources. Most ICT solutions which are available to VSEs, especially in emerging markets, are expensive and tailored to meet the needs and resources of enterprise that operate in developed countries (Kuyoro'Shade *et al*., 2013). Ashrafi and Murtaza (2008) highlighted that ICT adoption in developing countries remains a serious challenge because most enterprises in developing nations excessively rely on foreign products and services. Indisputably, Mukwasi and Seymour (2014) reported a growing trend of small businesses adopting ERP systems in developing countries. The success rate of ERP in small business has been low though (Mukwasi and Seymour 2014; Upadhyay *et al*., 2010) because these systems were initially developed to support large organisations in the developed nations and

they are unsuitable for businesses in developing countries (Rajapakse and Seddon 2005; Huang and Palvia 2001). The review of literature reveals that, in developing countries, the failure rates of enterprise based ICT solutions are in the range of 60% to 90% (Basu and Biswas 2013). Many researchers have put a lot of effort in studying the critical factors that lead to the failure of enterprise based ICT solutions in small businesses, including VSEs, focusing more on ERP systems. The studies of Chatterje (2015), Ogunyemi and Olofinsao (2014), Kaur and Aggrawal (2013), Ganesh and Mehta (2010) and Wong *et al*. (2005) discuss some the factors that are causing this adversity. However, what remains prominent is that most enterprise based ICT solutions are complex, demanding, risky and expensive to be adopted and implemented by VSEs (Ndhlovu 2014; Stanciu and Tinca 2013; Dumas 2008). Furthermore, they do not address the specific needs of VSEs; instead they impose their own logic, which usually calls for change in a way of doing business. Obviously, this is caused by the mere fact that most ICT solutions are not developed to directly meet the needs and resources of enterprises in developing countries.

Therefore, there is a need for enterprise-based ICT solutions that are developed specifically for enterprises in developing nations, to address their specific and unique business needs (Kuyoro'Shade *et al*., 2013; Ashrafi and Murtaza 2008). Most importantly, these enterprises based ICT solutions must be adaptable, affordable, and accessible to small businesses, in particular VSEs, and leverage their limited resources in some distinct economical viable ways.

2.4. **Frugal Innovation for VSEs in Developing Countries**

The issue of resource scarcity in small businesses can be identified in most research studies that are focused on issues and challenges of this sector. The limitations of resources among small businesses seem to be the main barriers that inhibit innovation and development within this sector (Woschke *et al*., 2017; Hessels 2008). This constraint appears to be relatively severe on VSEs (O'Connor *et al*., 2010). Most VSEs usually employ their limited resources to address their daily emergent problems in order to keep the business alive. While a number of VSEs have survived through this; however, many have failed. VSEs are resource-constrained in terms of financial resources, knowledge and information resources, and ICT resources. When compared with other enterprise categories, it is recognized that VSEs suffer more resource deficiency because of their nature and small size. This assertion is supported by Hadjimanolis (2000) who assert that an enterprise size indicates its resource availability. Due

to this resource poverty faced by VSEs, many of them struggle to achieve sustainable development.

A number of studies that are focused on development within small businesses through innovation have presented different propositions that could enable VSEs and other enterprises to use their existing resources more efficiently or increase their existing resources in order to meet the needs of their customers in an innovate way. Hessels (2008) investigated internalization as a strategy for small businesses that could help them to address their resource deficiencies. Löfqvist (2011) presented several approaches that can be implemented by VSEs so as to utilize their existing resources efficiently and this includes reducing formality and including customers and users in the design processes of their products or services, intertwining design processes, and adopting lead-user inventions, just to name a few. Löfqvist (2014) listed two helper methods, namely networking and bootstrapping, which can be explored by VSEs in order to manage their resources optimally. These few highlighted propositions are potentially useful in terms of managing resource scarcity in small businesses as far as development and innovation is concerned. However, this study devotes its focus on a relatively new philosophy called frugal innovation (Hyvärinen *et al*., 2016; Tiwari 2016; Hamarcher 2015; Bound and Thornton 2012) because it carries numerous benefits for both businesses and citizen's in developing countries.

There are numerous terms that have been used interchangeably with frugal innovation, such as reverse innovation (Lopez-Vega 2014), resource-constrained innovation (Ray and Ray 2010) and juggad innovation (Bhatti 2013). Nonetheless, the study of Zeschky *et al*. (2014) emphasizes that "these terms are structurally different from each other with respect to their original motivation, value proposition, and value creation mechanism". On the contrary, Hamarcher (2015) highlights that some scholars have used the term frugal innovation as an umbrella that constitutes the above mentioned innovation types. There are also many definitions of frugal innovation provided by different authors, but what is found to be noteworthy and seem to recur in the literature, is that this idea aims to serve low-income customers in developing countries, or emerging markets, who are at the bottom of the pyramid, through developing, under constrained resources, products and services that are of good-quality, affordable, easy to use, and serving their needs (Radjou and Prabhu 2015; Simula *et al*., 2015; Basu *et al*., 2013; Hossain 2013). However, frugal innovation is not only restricted to products and services; it is also applicable to enterprise processes and marketing methods (Khan 2016; Tiwari 2016). Bratti and Ventresca (2013) stated that "frugal

innovation is a label that captures a range of heterogeneous activities, which cut cross different sectors". These authors further proposed a value chain model of frugal innovation (Figure 1) to explain what needs to happen as part of frugal innovation process.

i) Upstream is a lack of resources such as capital, skills, and labour;
ii) Downstream means there exist clients who themselves are resource deficient;
iii) Upstream activities lie in an environment where there are institutional (soft) complexities or voids, such as lack of contract enforcement, rules, trust and legitimacy; and
iv) Downstream there is lack of (hard) institutional supply-chain and distribution infrastructure such as roads, ports, and transportation.

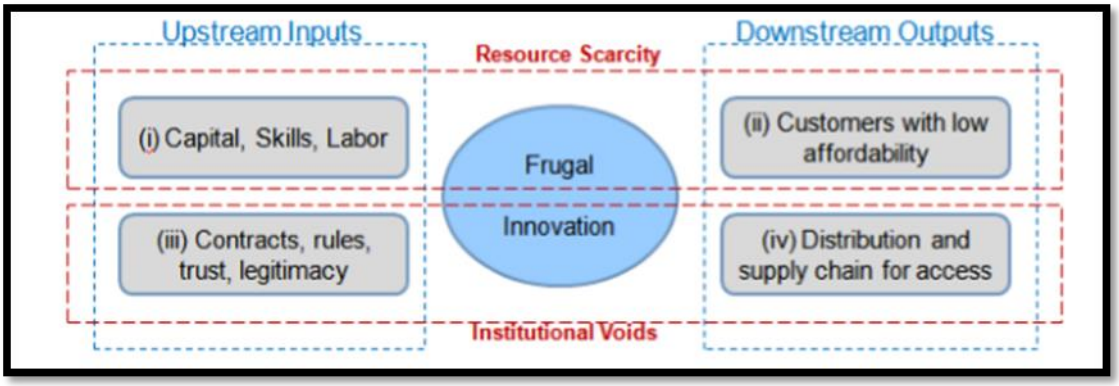

Figure 2.1: Value Chain Model of Frugal Innovation Based on Contextual Environment Process Model (Adopted from Bratti and Ventresca 2013)

There are a number of case studies where frugal innovation has been realized, in different sectors including health-care (GE HealthCare's Ultrasound and ECG machines), retail (Unilever's 1 rupee shampoo and sachet detergents) and manufacturing (Tata Nano Car, Dodrej's refrigerator). The key characteristics of frugal innovation are well documented in the studies of Basu *et al.* (2013) and Tiwari and Herstatt (2012), and they include affordability, use of local resources, light weight, simplification, robustness, user-friendliness, easy to use, green technology, minimal use of raw resources, adaptation, ruggedization, new distributed models, mobile enabled solutions, acceptable quality and human centric design.

Although Marosi and Katona (2015) revealed that small business are not yet ready for frugal innovation; however, VSEs come to view as potential players of frugal innovation. VSEs work closely with low-income customers in developing countries at the bottom of the pyramid, and they possess good knowledge and understanding of their needs and this is where frugal innovation begins (Hamacher 2015; Radjou 2015). On the other hand, VSEs can

gain more effectiveness and efficiency in their business operations, despite their resource scarcity, if they themselves employ frugal innovation, precisely frugal IS innovation (Sun *et al*., 2016).

2.4.1. **Frugal Information System intervention for Boosting VSEs**

Sun *et al*. (2016) and Sahay and Walsham (2014) affirms that frugal IS, sometimes called Frugal IS Innovation, is another form of frugal innovation. Frugal IS is defined as an information system that is developed and deployed with minimal resources to meet the pre-eminent goal of the users (Sun *et al*., 2016; Sakurai *et al*., 2014; Watson *et al*., 2013). Watson *et al*. (2013) emphasises that the definition of frugal IS has two essential points. The first point emphasises that a frugal IS must utilize minimal resources; and the second point stresses that the prime needs of the targeted users must be fully met and fulfilled. Unlike the traditional development of IS which may have numerous design goals, frugal IS only has one single prime design goal. Usually, secondary goals are avoided because they may likely cause undesired increase both in the development cost and system complexity; thus, devastating essential characteristics of frugal innovation such as affordability and simplicity. Watson *et al*. (2013) stated that frugal design does not force one to set the complexity of the system low; if complexity is present, it should not be visible and it needs to add substantial value to the system. If anything, the constraints that frugal IS are concerned to keep at low are time, resources, and scope (Watson 2013).

The foundation of frugal IS is based on four information drives, namely, ubiquity, uniqueness, unison and universality (Sakurai *et al*., 2014; Watson *et al*., 2013; Watson, 2013). Watson *et al*. (2013) proclaim that a frugal system should satisfy these drives which are explained in Table 2 Sun *et al*. (2016) argues that in order to effectively develop frugal IS there are three key factors which need to be considered: strategic imitation, product virality and user-centricity. They demonstrate these factors using a case study of Weqia.com. There are other case studies of frugal IS development which are reported in the literature. For instance, Watson *et al*. (2013) reports two case studies (that is Ushidi and RuralNet) of frugal IS development and discusses how these systems satisfied the information drives of frugal IS. Another interesting case is that of a frugal health IS called HospIS which was designed and implemented to support the public health sector of India state (Sahay and Walsham 2014). HospIS empowered patients and enabled them to make better choices on treatments to improve their health conditions. The development of frugal IS has numerous

economical, technological, and social benefits that businesses such as VSEs, and citizens in developing countries can yield (Olugbara 2014). Some of these aids are quite apparent in the highlighted case studies.

Table 2.2: The information drives of frugal IS (Adopted from Watson et al. 2013)

Drive	Definition
Ubiquity	The drive to access to information unconstrained by time and space.
Uniqueness	The drive to know precisely the characteristics and location of a person or entity.
Unison	The drive for information consistency.
Universality	The drive to overcome the friction of information systems' incompatibilities.

According to Watson *et al*. (2013) the greatest benefit of frugal IS will come from infopowerment for those at the bottom of the pyramid. Frugal IS has potential to serve many disadvantaged individuals, households and businesses in emerging economies with knowledge and information that is critical to their quality of life (Watson *et al*., 2013). For businesses such as VSEs who are normally operated in poor and disadvantaged environments and constantly faced with numerous critical issues and challenges including resource-scarcity, frugal IS can have a substantial impact in developing and sustaining these enterprises. Consequently, this may steer the VSEs towards participating in a knowledge-based economy and thus closing the digital divide pointed out by Ndhlovu (2014). Moreover, frugal IS can fuel more effectiveness and efficiency in business operations of VSEs (Sun *et al*., 2016) which in return may potentially improve their business performance (Khan 2016) and deliver sustainable growth and success in this sector.

Most frugal innovations feature low cost technologies such as mobile phones (Numminen and Lund 2017). Previous research findings have shown that there is high use of mobile phones among small businesses, including VSEs, in developing countries as well as in South Africa (Mbuyisa and Leonard 2015; Olugbara and Ndhlovu 2014; Melchioly and Sæbø 2010; Esselaar *et al*., 2007). Njau and Njunga (2015) stresses that mobile phones are crucial for development in developing nations because they bypass the infrastructure barriers, ease to use, and affordable. Kivea and Ofafa (2013) highlighted that it is the special characteristics of mobile phones that cause them to be adopted. In fact, mobile phones are regarded as the most vital instrument for social and economic development, particularly in developing countries context. They are viewed as a catalyst for increasing productivity, networking and

information gathering tool for small businesses (Donner and Escobari 2010; Melchioly and Sæbø 2010). According to Watson *et al*. (2013) mobile phones are a convenient platform to delivering frugal IS. Sakurai *et al*. (2014) asserts that the information drives of frugal IS are most likely to be fulfilled by mobile phones and their ability to connect to the internet.

2.5. **Mobile Technologies in VSEs**

Mobile technologies, precisely mobile phones, offer a variety of benefits to an enterprise such as ubiquity, convenience, interactivity, personalization, localisation, connectivity and collaboration (Ducombe 2013; Barnes 2002). Nevertheless, the main advantage of mobile phones which is mostly underlined is their ability to function anywhere and anytime. Kuyoro'Shade *et al*. (2013) argues that it is not enough for VSEs to just have mobile phones; this technology should enable them to grow their business. In Kenya, mobile phones have increased efficiency of many small businesses operations and boosted their growth through mobile money services (Simiyu and Oloko 2015). Njau and Njunga (2015) assert that mobile technologies have both advantages and disadvantages in the performance of small businesses. They are advantageous because they provide small businesses such as VSEs with low cost base and ability to effortlessly communicate with their suppliers and customers. They are disadvantageous because of their limitations in terms of functionality and inability to develop as the business develops (Mbuyisa and Leonard 2015; Njau and Njunga 2015). Many researchers propound that the impact of mobile devices is small businesses, including VSEs, results from the mobile device functions and mobile data (Onyangos *et al*., 2014).

Different mobile phones offer various functions and capabilities. Most VSEs in developing countries have simple and affordable mobile phones or less expensive smartphones with limited functions. The use of mobile phones among VSEs is still limited to basic communication services such as voice call and SMS (Deen-Swarray *et al*., 2013; Kiveu and Ofafa 2013). This constraint is primarily caused by the low level of literacy, especially in the rural areas, as we have seen that majority of VSEs in the rural areas are less educated and lack knowledge and skills of ICT. However, Aker and Mbiti (2010) state that mobile phones in Africa are evolving into service delivery platform. In Ghana, there is a mobile service called Esoko which delivers the latest market prices to the farmers via SMS. In Kenya, a mobile service called M-Pesa exists which facilitates a variety of financial transactions for different users, including small businesses owners, such as transferring money, purchasing airtime and paying bills. In South Africa, First National Bank (FNB) implemented a mobile

baking application which can be used by any mobile phone regardless of its make or model, to send money to anyone in South Africa (FNB 2016). According to Hosman and Fife (2012), "African development and a great deal of creativity have been exhibited in the creation of applications which take advantage of the mobile phone's capabilities". Donner and Escobari (2010) states that these applications take advantage of everything from basic SMS services to voice prompts and voicemail, to mobile internet applications and browsing experience.

Nevertheless, there has not been much effort devoted to designing and developing a suitable mobile application that addresses the challenges of VSEs such as financial management or marketing. Shafique *et al*. (2013) posits that VSEs are failing to find appropriate solutions for their problems such as record keeping. The review of literature indicates that not much has been done in terms of exploring the mobile platform for delivering a solution that solves challenges of VSEs. Basu *et al.* (2013) highlighted mobile enabled solution as one of the important characteristic of frugal innovation.

The lack of financial management amongst VSEs is not necessarily what causes these enterprises to fail, but the problems such as insufficient skills and knowledge of financial management practice, poor record keeping, inadequate financial reporting, and poor cash flow management. For example, there are staggering findings which revealed that about 60% of small businesses, including VSEs, have failed essentially because of poor record keeping (Chelimo and Sopia 2014). A number of research studies have failed to provide a good-enough solution to such problems; instead many researchers have been good at providing recommendations to government, policy makers and small business agencies. There are quite a few solutions which have been developed specifically to address the problem of poor record keeping that is faced by VSEs. FrogTek developed a smart phone application called Tiendatek, specifically for Latin American shops, which allows low-income entrepreneurs who run small businesses such as VSEs to systemize their enterprise by managing their sales, expenses, inventories, payment to supplier and earnings (Schoar 2012). The Tiendatek system is designed with a simple and clean interface and uses minimal accounting jargon, but the issue with this system is the demand of constant supply of electricity to support the external bar code reader which enables the transaction to take place at product level. Apart from VSEs not having smart phones which are mandatory in the case of Tiendatek system, they cannot also afford the demand of resources that comes with this system.

Nokia also developed a mobile-based system called MyShop with the aim of filling the gap of insufficiency in terms of applications that support small business management in

developing world. The MyShop system focuses on helping small enterprise owner/manager to keep track of their business transactions and this system performs four main functions: recording sales and expenses, managing inventory, selling stock, and monitoring of enterprise performance (Baguma *et al*., 2013). Despite the system having germane functions for managing small businesses, it failed to support credit transactions. Olugbara and Ndhlovu (2014) states that trade credit is a vital strategy for VSEs to attract customers. This strategy of VSEs is also recognized as an efficient tool for boosting their sales and increasing profitability (Tang 2014). Thus, any system that neglects this essential function is inevitably bound to displease and demotivate VSEs.

Palser and Marsden (2011) developed a mobile bookkeeping application that enables small businesses to keep records of their business transactions and automatically generate financial reports. Baguma *et al*. (2013) argues that this application is not available in the public domain, thus it is not clear whether it went beyond the university laboratory. Furthermore, there are compatibility issues which are associated with Palser and Marsden (2011) application since it is platform specific, that is to say, it is not inherently cross-platform compatible. Consequently, this makes their application less ideal for VSEs who own mobile phones that operate on different platforms, let alone that this application would be irrelevant to the business context of VSEs.

Olugbara and Ndhlovu (2014) designed and developed a frugal sales system called MobiSales which specializes on documenting daily sales transactions of VSEs. The MobiSales system is deemed as a management system for VSEs, characterised by low costs, requiring low education levels and little ICT skills. VSEs reported that, during the evaluation, the system was useful, easy to use, and beneficial in terms of managing their sales business transactions. However, although MobiSales system proved to be valuable to VSEs, there are still improvements that need to be made in order to fully support the business processes of VSEs. It is also noteworthy that even Olugbara and Ndhlovu (2014) do not claim completeness in their solution; rather they call for further research to incorporate more commanding functions. Actually, some VSEs expressed that the improvement of MobiSales should incorporate a function that manages their business cash flow. It is noteworthy that providing management of cash flow to VSEs could help them to function more economically, effectively, and efficiently (Reyder and Heyler 2003). In addition, since MobiSales systems focuses only on the monies that are coming into VSEs, a function that supports all the monies that are going out of VSEs can be significant because it is critical for any enterprise to keep

proper records of all business transactions in order to realize success and survival of the business (Mutua 2015; Chelimo and Sopia 2014).

Based on this account, this research builds on the solution developed by Olugbara and Ndhlovu (2014). Palser and Marsden (2011) advices that an ideal system for an enterprise such as VSEs should include information backups, minimal accounting jargons, quick and easy data entry, clear and simple interface and affordable at low cost. Baguma *et al*. (2013) added that it must be effortless to use, relevant to the needs and context of the business, add value, pleasurable and stimulating to use. It is important to note that the solution of Olugbara and Ndhlovu (2014) targeted mobile systems that operate on android platform; and this platform dependency restrained many VSEs who had mobile phones that had low device capabilities and operated on different platform. Therefore, clearly it is prudent to fastidiously consider the most ideal system architecture when designing any system because failure to do so may cause various challenges including inaccessibility and unsatisfactory of meeting client's needs.

2.6. **Mobile System Architectures**

The decision of selecting the most ideal system architecture when designing a frugal IS or any other system is often a difficult task as there are several available alternatives involved in the selection process (Kumar 2014; Zayaraz and Thambidurai 2005). In addition, there are many factors such as performance, security, maintainability, quality, reusability and flexibility that need serious consideration. This is one of the reasons that selecting an appropriate software architecture is recognised as a multi-criteria decision-making problem (Wang and Yang 2012; Babu *et al*., 2011). Of course, there a number of researchers such as Wang and Yang (2012), Vijayalakshmi *et al*. (2010), Babu *et al*.(2010) and Zayaraz and Thambidurai (2005) who have suggested different models including analytical hierarchy process and analytic network process to address the issue of software architecture selection. However, this dissertation focuses not in selection of software architecture; but rather on reviewing the four types of widely used client-server architectures for mobile IS solutions (Gruhn and Kohler 2007). These client-server architectures are highly relevant to review since this dissertation aims to develop a frugal IS for VSEs which piggybacks on mobile technology. Kim and Gelogo (2013) asserts that the differences in mobile system architectures need fastidious consideration during the development process to reduce chances of selecting an inappropriate architecture. This points to the fact that selecting the most

suitable mobile system architecture is one of the most essential part of design and development of a frugal IS (Wang and Yang 2012; Vijayalakshmi *et al*., 2010).

The client-server architecture is a software architectural style for distributed systems which consist of a client side and a server side (Oluwatosin 2014). Typically, in this architecture, the client establishes connection with a server via a network using standardized communication protocol such as hypertext transfer protocol (HTTP) and consequently the server performs the necessary data processing, based on client request, and returning the result back to the client. According to Gruhn and Kohler (2007), there are four main types of client-server architectures that can be applied when developing a mobile-based system, namely rich client architecture, rich client hybrid architecture, fat architecture and web-based architecture. These architectures are reviewed in the Table 3 in terms of their advantages and disadvantages.

Table 2.3: The advantages and disadvantages of four types of mobile client-server architectures

Architecture	Advantages	Disadvantages
Rich Client Architecture	-High user quality experience. -Reduced data traffic. -Database centralization. -Minimal administration effort.	-Inconsistency network connection. -Permanent need for network connection. -Components for session and update handling need to be developed.
Rich Client Hybrid Architecture	-Ability to work both online and offline -Database locally hosted. -Rich user interface design -High performance	-Components for session and update handling need to be developed. -High administration effort needed.
Fat Architecture	-No need for a network connection -Exceptional performance -Flexibility	-Data consistency cannot be assured. -Components for session and update handling need to be developed and deployed regularly.
Web-based Architecture	-Only the browser is need on the client. -Database centralization. -Minimal administration effort. -Updates and synchronisation mechanisms are not needed.	-Mobile devices capabilities are very restricted. -Permanent need for mobile network connection. -Performance varies

Sakurai *et al*. (2014) argues that the information drives of frugal IS are most likely to be fulfilled by mobile phones and their ability to connect to the internet. Therefore, a process of selecting the choice of a system architecture, particularly the one that is geared toward the design of a frugal IS, needs not to neglect this information but rather it should be governed by it. Moreover, attributes such as software distribution, point of service, source code redundancy and security are also of paramount to consider (Gruhn and Kohler 2007). The web-based architecture displays the ability to support a design of mobile enabled solutions that could be distributed across all platforms because the client only requires a web browser which is available in most mobile devices. This architecture addresses the issue of platform incompatibility. Additionally, the web-based architecture proves to be frugal in terms of development cost and time because there is no development of components such as update handling, session handling, and synchronisation that is required. Watson *et al*. (2013) emphasised that a frugal IS need to keep resources such as time, cost, and scope at low levels. Gruhn and Kohler (2007) stated that a web-based architecture is lightweight and this characteristic maps itself naturally with frugal innovation.

2.7. **Development Approaches for Mobile Systems**

There are currently three distinct fundamental approaches which are currently used for developing mobile-based systems: native, hybrid, and web-based (Tun 2014; Joorabchi *et al*., 2013; Dalmasso *et al*., 2013). These approaches are relevant in a sense that they tie with the above reviewed system architectures. It is worth mentioning that SMS-based approach is not part of this review although it breeds frugal system. In mobile-based development, whether frugal or not, choosing the appropriate approach amongst the aforementioned is a daunting task. The question of which approach to adopt is inevitable for both developers and enterprises who want to build a mobile system. This is caused by the mere fact that each approach has its own key characteristics, advantages and disadvantages. However, the literature reveals that there is no approach that dominates the other two (Mehta 2012).

Since the development of the mobile enabled system is relatively emerging, there are a relatively limited number of academic research papers (Charland and LeRoax 2011; Dalmasso *et al*., 2013 Mbayen 2013; Xanthopoulos and Xinogalos 2013; Lim 2015; de Andrade *et al*., 2015) that specifically enunciate the differences between these three development approaches. However, Holzer and Ondrus (2012), Masi *et al*. (2012) and

Mbayen (2013) have dedicated some efforts in developing decision models and frameworks that are aimed at addressing the concern of which approach to consider. On the other hand, despite these research efforts, it appears that the decision of the right approach heavily relies on the purpose of the solution to be developed.

As we know, different mobile-based frugal systems would have different purposes; however, the targeted audience would be the same. The customers in developing nations who have low purchasing power and use inexpensive technologies cannot afford the sophisticated smartphones that typically come with rich capabilities that support extraordinary features. As far as VSEs are concerned, they have limited access to advanced ICT technologies (Olugbara and Ndhlovu 2014), thus their system would require basic functionality and minimal feature sets that address their pre-eminent specific needs. Leadbeater (2014) writes "clustering a system with extraneous features adds to the cost without delivering substantial additional value to the user". Most customers in emerging markets are cost sensitive and they are not willing to pay for too many features, especially if they perceive them non-valuable (Simula *et al*., 2015). Consequently, the development approach for a mobile enabled system needs not to focus on accessing extraordinary features because that might discourage the utilization of the system to be developed. Furthermore, it should consider the capabilities of the mobile technology that the targeted audience already has (Watson *et al*., 2013) and ensure to satisfy the four information drives of frugal IS.

2.7.1. **Native Approach**

The native approach is specifically for building mobile-based systems that run on certain devices which are supported by a particular mobile operating system (Tun 2014). This approach typically breeds 'native mobile applications' which are executable binary files that run directly on a specific platform. This means that native applications are platform dependent. The platform dependency of native applications signifies that different mobile platforms cannot run the very same native application which is targeted to a singular platform. However, native systems have the power to fully integrate with the latest technology available on mobile devices, both hardware and software built in the applications. Since the native approach has the ability to leverage all resources that are available on mobile devices, their major advantages are high quality user experience (Isakson 2013; Redda 2012) and high performance (de Andrade *et al*., 2015; Lim 2015). Their ability to produce systems that run offline, directly on the mobile operating system, has a meaningful impact to their

peak performance. The major drawbacks of native approach are expensive development cost and high maintenance time (Lim 2015; Dalmasso *et al*., 2013; Joorabchi *et al*., 2013). This is mainly caused by the fragmentation across mobile platforms which forces that different native systems, of the same version, be developed, thereby increasing cost and time. Consequently, maintaining a solution that runs on different platforms is complex and time consuming because each platform has its own human computer interaction standards and design guidelines to adhere to seamlessly.

2.7.2. **Hybrid Approach**

Hybrid approach supports the development of mobile systems that are cross platform, capable of operating offline, and have the ability to fully access device capabilities (de Andrade *et al*., 2015). Hybrid system are developed using web technologies which are executed inside a native app container to empower access to local device capabilities. Local device capabilities are accessed through a set of JavaScript APIs to allow hybrid applications to tap into native features (de Andrade *et al*., 2015; Dalmasso *et al*., 2013). These native features include geo-location, near field communication (NFC), camera, contacts, videos, accelerometer, and many more. Hybrid systems are typically built using frameworks such as PhoneGap, Titanium Appcelerator, Xamarin and RhoMobile.

The main advantage of hybrid approach is the ability to develop a system once, using common web technologies, and deploy it on multiple platforms (de Andrade *et al*., 2015; Tun 2014; Isakson 2013). This reduces development cost and maintenance time because there is only one single base code that needs to be developed and maintained. Hybrid systems also maintain a consistent user interface across different platforms (de Andrade *et al*., 2015; Rahul and Sechu 2012; Mehta 2012). This makes it easier to create universal mobile systems, as oppose to keeping up with different user interface components for different platforms. Although hybrid approach gives the impression of breeding native like systems, their performance still depends on the ability of a rendering engine, which executes web components within a browser (Rahul and Sechu 2012).

2.7.3. **Web-based Approach**

Mobile web-based approach is primarily for designing web-based systems that are optimized to run on mobile space, and are accessed through mobile web browser (Tun 2014). These systems are built using common web technologies such as HTML, HTML5, CSS, and JavaScript. Mobile web systems are fast and inexpensive to build because they only require common knowledge of web technologies. Their major advantage is cross platform compatibility (Tun 2014). Mobile devices that run on any platform (Android, iPhone, Blackberry, Windows Mobile, Symbian, and more) can easily access a web-based system using a web browser. The web-based approach provides a consistent, unified and standard look-and-feel across different platforms in their solutions. Furthermore, centralization of one single base code in the hosting web server makes it effortless and cheap to maintain mobile web system (Tun 2014). Updates are straightforwardly pushed to the web server, and all subsequent mobile platforms receive the latest version of the system instantly. If responsive design is practiced, a mobile web-based approach can address inherent constraint of mobile screen size, by presenting a system on the user based on the mobile device capabilities. Although some mobile web-based system that are built using HTML5 can access some mobile capabilities, but most hardware resources and native features are still restricted (Lim 2015; Heitkotter *et al*., 2012; Tun 2014). The performance of mobile web-based systems may be relatively slow because the systems are highly dependent and require internet connection in order to function. However, given a reliable internet connection, the performance of web based enabled system is mostly convenient.

2.8. **Conclusion**

This chapter provided a lucid insight on the nature, characteristics and contributions of VSEs. It pointed out that VSEs have a significant role to play in employment, youth and adult development, poverty alleviation, and economic growth of emerging and developing countries. Furthermore, the issues and challenges that hinder VSEs from experiencing growth and tasting success in their sector were well articulated in this chapter. What was remarkable is that most of the issues and challenges that are faced by VSEs are primarily caused by resource limitations and lack of knowledge, education and skills in different business aspects. The philosophy of frugal innovation, precisely frugal IS, was explored as an intervention that could assist VSEs in addressing some of their challenges such as financial management, marketing, as well as knowledge and information management under constrained resources.

This chapter also reviewed the existing mobile enabled systems for VSEs. This research builds on the solution developed by Olugbara and Ndhlovu (2014) to specifically address the critical problem of financial management amongst VSEs. The other section of the chapter presented mobile client-server system architecture and approaches for developing mobile enabled systems. The web-based architecture exhibited characteristics that favour frugal IS and promoted a design that will be supported by all mobile technologies that VSEs already have. Most frugal systems which are reported in the literature are either SMS-based (RuralNet) or web-based (Weqia.com; Ushidi.com). Therefore, considering the architecture that is suitable for developing a solution for VSEs and the highlighted frugal attributes of web-based development approach, it is safe for a system targeting VSEs to be a web-based frugal IS. The next chapter will explain the methodology that was followed in this dissertation.

CHAPTER 3: STUDY METHODOLOGY

This chapter provides a brief description of design science research (DSR) paradigm and highlights the rationale for selecting this paradigm to anchor the research study. Furthermore, it uncovers a research methodology called design science research methodology (DSRM) (Peffers *et al.*, 2008) which served as a framework for this study. A novel life cycle model for web-based application development (Huang *et al*., 2010), which was adopted particularly for the purpose of designing and developing a quality mobile web-based frugal IS, was associated to DSRM. The model favoured the notion of frugality and suited the development of the artefact. This chapter is structured as follows. Section 3.1 briefly explains DSR paradigm. Section 3.2 explains the six nominal activities of DSRM and how they were related to the research study. This section also links the innovative web-based application development model to DSRM. Section 3.3 validates the significance and suitability of DSRM using the seven guidelines suggested by Hevner *et al*. (2004). Section 3.4 provides a conclusion of this chapter.

3.1. Design Science Research Paradigm

A paradigm can be defined as a philosophical perspective and a set of assumptions, values, concepts and practices which guide a group of people (researchers, consultants, managers) on how to act and behave (Wahyuni 2012; Göktürk 2011; Jonker and Pennik 2010; Mutaz 2010). According to Mutaz (2010) there are four research paradigms which can be applied in IS research: *interpretive*, *positivity*, *critical postmodernism* and *design science research*. These paradigms were reviewed with a goal of making an informed decision as to which paradigm best fits the research study and to mitigate the position of being bias. Consequently, the design science research (DSR) paradigm was found to be the most suitable paradigm for the following reasons.

The DSR paradigm focuses on addressing the problems of people and organizations through design, construction, utilization, and evaluation of artefacts that seek to transform the current situation to a more desirable one (Kuechler and Vaishnavi 2008; Hevner *et al*., 2004). The process of designing and developing artefacts in DSR relies much on kernel theories that are applied, tested, modified and extended through the experience, creativity, intuition, and problem solving capacity of the researcher (Hevner *et al*., 2004). The artefacts that evolve from a DSR oriented study are broadly classified by March and Smith (1995) into four

categories: i) constructs, ii) models, iii) methods, and iv) instantiations. However, relatively recently, Peffers *et al.* (2012) classified six different types of DSR artefacts: algorithm, construct, framework, instantiation, method, and model. The literature of DSR emphasises that it is crucial that the artefacts are utilized for their purpose and evaluated. Hevner *et al.* (2004) states that further improvements in the artefact can be realized if evaluation is performed thoroughly. Ultimately, the final artefact should solve the identified problem and provide an opportunity to refine or develop new knowledge (Kuechler and Vaishnavi 2008).

The study selected a DSR paradigm as the philosophical approach because its overall intention is to change the current problematic situation of VSEs to a more desirable one. This is set to be achieved through designing and developing a mobile web-based frugal IS that supports the business of VSEs. Additionally, based on the two underlying design processes of DSR which were identified by March and Smith (1995), which are build and evaluate; the researcher realized that there is an undisputed connection between these processes and the objectives of this dissertation. Firstly, the objective of this dissertation, which aims at developing a mobile web-based frugal IS was associated with the design process of building. Secondly, the objectives of this dissertation that are centred on evaluation are linked with the design process of evaluation. On this account, it was logical and safe to deem DSR suitable for this study. Moreover, Hanid (2014) revealed that, by looking at the history, DSR has some of its roots in management accounting. In fact, many researchers in the domain of management accounting have used this paradigm because it is accepted as a legitimate approach. Therefore, since this research study deals with the aspect of recording, organizing, maintaining and analysing business transactions of VSEs, it was eligible to view it from the perspective of management accounting, thereby making DSR a pertinent and most fitting paradigm.

3.2. **Design Science Research Methodology**

Peffers *et al.* (2008) developed a DSRM for IS research. Their work was motivated by the lack of a consensus process for carrying out and presenting a DSR in the IS discipline. This methodology, DSRM, is built upon key prior literature of DSR in the IS and other relevant disciplines. Figure 3.1 presents the DSRM process model which was applied in order to realize the artefact of this research.

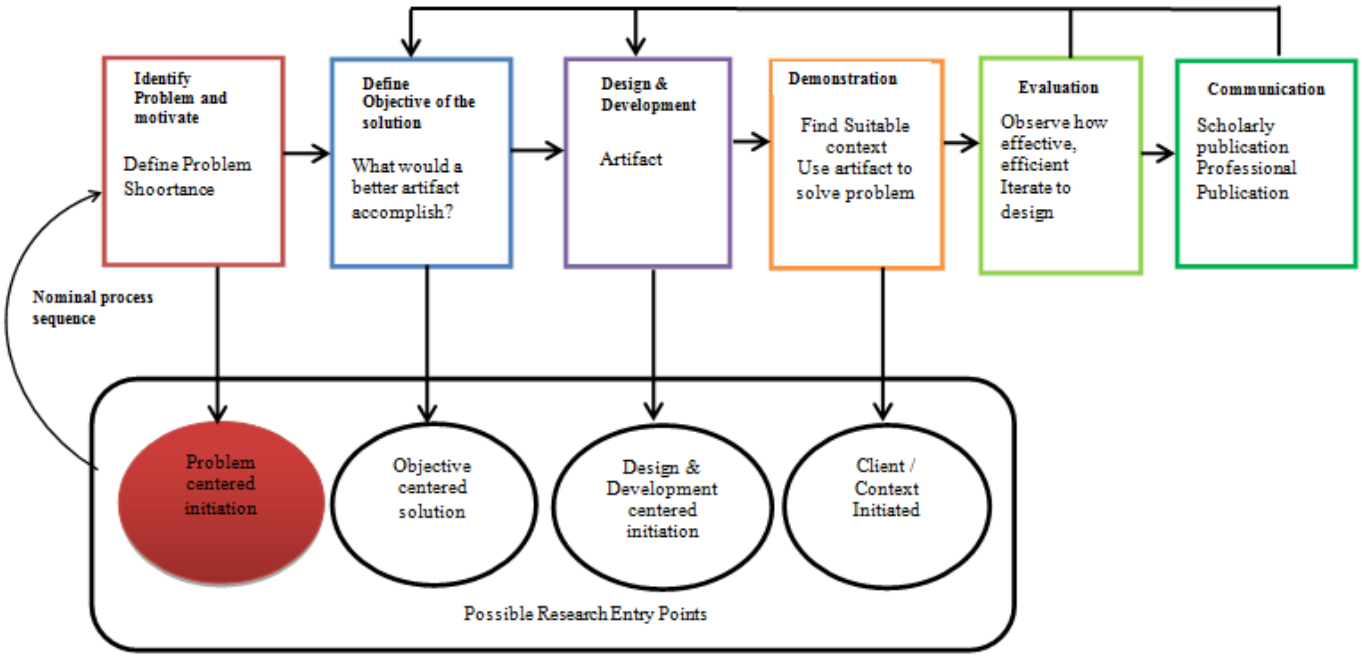

Figure 3.1: Design Science Research Methodology Process Model (Adopted from Peffers et al. 2008)

Peffers *et al.* (2008) assert that it is not compulsory for a researcher to sequentially follow the activities of DSRM in their order. Depending on the nature of the problem, the researcher may initiate the study in any of the activities; expect the last two which are not connected to any research entry points. Furthermore, they define four possible research entry points that the researcher may follow, namely, problem-centred initiation, objective-centred initiation, design and development initiation, and client/context initiation. The problem-centred initiation entry point was followed in the case of this study. The literature that focuses on the challenges of VSEs was reviewed and, conjointly, the VSEs were visited to understand their problems in real-world context. Hence, the problem-centred initiation entry point was appropriate.

3.2.1. **Identify Problem and Motivate**

The first activity in the DSRM is essentially about identifying a research problem and justifying the value of the solution (Peffers *et al.*, 2008). According to Hevner *et al*. (2004), in IS research, a problem may arise from people, technology, or business. The problem that is being addressed in this dissertation arose from the business of VSEs. The problem was identified through a comprehensive review of literature on VSEs in conjunction with a direct engagement with VSE owners/managers. The review revealed that most VSEs are faced with a problem of keeping proper records of their business transactions (Hishigsuren *et al*., 2014; Ndhlovu 2014; Olugbara and Ndhlovu 2014), which has caused many enterprises to cease (Chelimo and Sopia, 2014). A contextual inquiry method, which is part of the contextual design process (Holtzblatt and Beyer 2013; Beyer and Holtzblatt 1999), was used to facilitate direct engagement with VSEs. Using this method for the purpose of identifying the difficulties of VSEs was only fitting because contextual inquiry method helps at understanding how users work on a day-to-day basis and what kind of problems they are faced with (Holtzblatt and Beyer 2013).

The VSEs were informally visited and the data were collected through observations, note-taking, discussions, and asking questions. Subsequently, the business needs of VSEs were identified. The major problem of VSEs that was identified was poor financial management, which was brought about by poor record keeping. It was observed that only a few VSEs kept their business records and that those records were often sloppily scribbled and extremely unprofessional. This is why, during the engagement, many VSEs failed to give accurate and adequate information when asked about their profitability, cash flow, sales and expenditures. Additionally, they couldn't precisely communicate how much money they were spending on their business; whether there was an increase in their sales or not; and how much money was coming in and going out of their business. It was noticed that these challenges of VSEs, which were primarily bred by poor record keeping, were in accordance with the literature.

Greets (2011) suggests that at this stage, after identifying a problem, a researcher should try to understand the current solutions that exist for that particular problem. In chapter 2 of this dissertation, the existing solutions for the identified business problem of VSEs were reviewed and their weaknesses and strengths were articulated. It was decided that this research study would build on the work of Olugbara and Ndhlovu (2014). This decision was considered significant and relevant to DSR which is sometimes called "improvement

research" (Vaishnavi and Kuechler 2013). Furthermore, any study that follows DSR can solve a problem which has already been addressed; however, the proposed solution should be more effective or efficient than the existing one (Hevner *et al*., 2004).

The solution which was proposed was a frugal IS that essentially aimed at supporting business transactions of VSEs. In addition, the solution intended to integrate business processes and information of VSEs, and deliver automation and consistent. Unlike the existing solutions which are limited in various areas such as functionality, interface design, reliability and learnability, the proposed frugal IS targeted ameliorates on such shortcomings to achieve the most ideal solution for VSEs. The proposed solution was specially built to improve on the work of Olugbara and Ndhlovu (2014). Nevertheless, the suggestions which are found in other related studies such as Baguma *et al*. (2013) and Palser (2011) were considered in the process of actualizing effective solution for VSEs. The solution aimed at keeping and managing VSE business information that is timely, accurate, and reliable. It was expected that this information would be useful for VSEs in terms of financial management planning and control and it would help them make sound business decisions which would subsequently improve their financial management. Efficient financial management would increase the business performance of VSEs (Turyahebwa *et al*., 2013), which in turn would help to avoid business failure.

3.2.2. **Define Objectives of the Solution**

The second activity in DSRM demands an answer to a question: "what would a better artefact accomplish?" This question was considered relevant to the research study because its final output is viewed as improvement of an existing solution. Peffers *et al.* (2008) suggest two ways of defining the objectives of the proposed solution: qualitative or quantitative. The first objective of the solution was to design a mobile web-based frugal IS that has low complexity. It was considered critical to conceptualize an architectural design of the solution that has low complexity because the more complex the system is, the more expensive and risky is the development effort. In the case of this study, although Watson *et al*. (2013) argues that frugal design does not mean low complexity, if a solution is built on a design with high complexity, the development, reusability and maintainability would be expensive and require a great amount of effort and this would violate the notion of frugality. The second objective of the solution was to develop a mobile web-based frugal IS that supports all important business transactions of VSEs. According to the literature, it is vital for any enterprise to keep records

of all business transactions in order to realize success (Mutua 2015; Chelimo and Sopia 2014). The third objective was to make the solution cross platform and cross-browser in order to deliver its services to a wider audience of VSEs. The proposed solution was called MobiSalesX system, where "X" denotes the extension or improvement that are incorporated into existing MobiSales(Olugbara and Ndhlovu 2014). Through this proposed solution it was envisaged that the existing situation of VSEs would be transformed to a more preferred one which has, at heart, development, growth and success

3.2.3. **Design and Development**

The third activity of DSRM focuses on the creation of an artefact in the form of a construct, model, method, or an instantiation (Vaishnavi and Kuechler 2013; Hevner *et al*., 2004). The artefact that was developed can be classified as an instantiation. Hevner *et al.* (2004) indicate that an instantiation is "a type of system solution". A novel life cycle model for web-based application development, proposed by Huang *et al*. (2010), was adopted to design and develop the artefact. Figure 3.2 provides a diagrammatic illustration of this novel life cycle model.

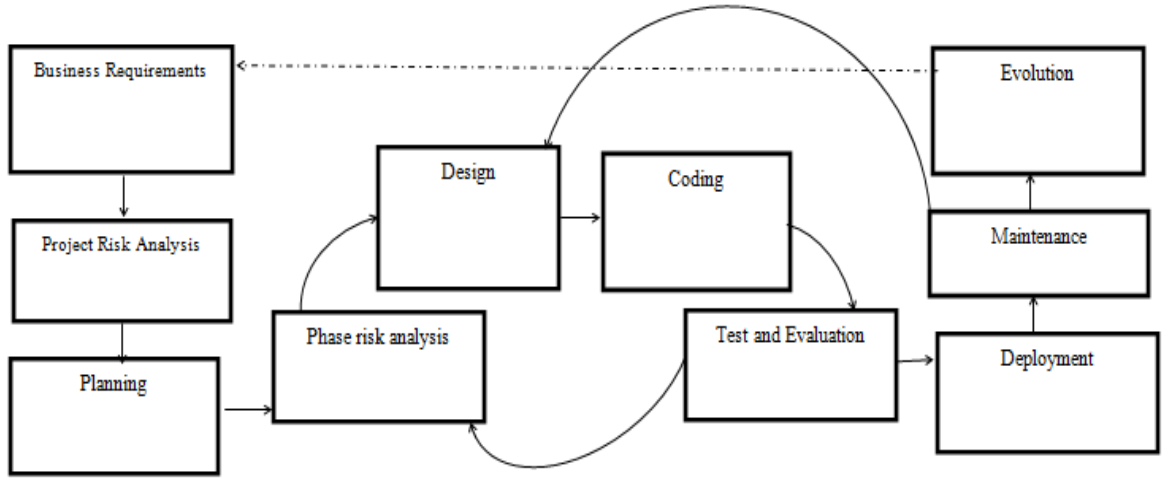

Figure 3.2: The adopted web-based application development life cycle model (Adopted from Huang et al. 2010)

According to Huang *et al*. (2010), the model can be summarized in three major processes, namely requirement process, development process and evolution process. Though this activity in DSRM focuses on design and development; however, it was imperative to first consider the requirement process because the solution of VSEs had to be designed based on their business requirements. The activities that were considered in this process included gathering business requirements, conducting project risk analysis and rigorous planning. It was before proceeding with the development processes.

3.2.3.1. **Requirement Process**

To gather proper business requirements, it was significant for the researcher to establish a salubrious relationship with VSEs. This was achieved through visiting a number of VSEs at their workplace. Because the researcher was proficient in the languages that most VSEs knew, the communication between the two parties was transparent. Chapter 4 of this dissertation addresses a set of realistic business requirements that were ultimately gathered from VSEs. The project risks were analysed and then a rigorous project plan, with deadlines, was actualized. The risk analysis process was critical as it was viewed as a bridge for mitigating failures. Đurković, and Raković (2009) state that the development of IS solutions is a sophisticated process which is susceptible to a great number of risks that could be categorized as known risks, known risks with unknown costs, and unknown risk.

The risks that were identified for the development of the frugal IS solution for VSEs, using one of the modern methods of risk identification called brainstorming (Dinu 2012), included ambiguous business and user requirements, unclear design goal, inflexible system architectural design; inappropriate new technologies, software tools, programming languages, and resource shortfalls. The risks that dishonoured the notion of frugality were eliminated and mitigated in order to improve, to a great extent, the possibility of actualizing a successful solution. In the aspect of planning, the tasks that had to be performed in order to achieve the objectives that are discussed in Section 3.2 were identified and broken down into small phases and listed according to priority. The literature highlights that are using the prioritization method can help lower risks, increase efficiency and optimize resources utilization, which in turn could result in faster deliveries of key requirements. The desirable resources were assigned for every phase. Huang *et al*. (2010) state that "in planning, high-level planning aspects such as the abstract types of components, relationships, and functions are identified and resources assigned to them".

3.2.3.2. **Development Process**

To initiate the development, it was essential that the risks that were associated with the phases which were identified in the planning process be explicitly analysed and managed. With respect to the phase that involved ascertaining business and user requirements, there were potential anomalies that were identified. The researcher conducted a small group discussion with the VSEs to resolve these anomalies. This practice fitted well with

suggestions that are maintained in the literature regarding requirement elicitation, especially where there are ambiguities and conflicts that exist in points of view. Furthermore, a paper-based prototype technique (Maguire and Bevan 2002) was used to validate and refine the user requirements of VSEs. Ultimately, the requirements that informed the development of the solution were obtained.

It was of vital importance to first model the IS solution that was proposed, based on the requirements that were attained, in order to reason better about the behaviour and functionalities that were going to part of the solution, before commencing with the development phase. In IS, modelling has long been viewed as an indispensable requisite to design successful systems. Since this study followed a paradigm which does not dictate any modelling techniques for illustrating the system behaviour, structure, or architecture; the researcher applied a widely used object-oriented modelling language called unified modelling language (UML). A formal specification language called object constraint language (OCL) was used to complement UML models. Bajwa *et al*. (2010) maintains that "OCL can be used as part of UML model to significantly improve the clarity of software models and make models more precise". Hence, specifying the aspect of system design in detail (Cabot and Gobolla 2012).

Later, the solution of VSE was designed based on the four information drives of frugal IS, namely, ubiquity, uniqueness, unison, and universality (Watson 2013; Watson *et al.*, 2013). Watson *et al.* (2013) states that a frugal solution should still strive to meet these drives. Furthermore, the principles and practices of frugal IS design were followed in the process of modelling an effective solution for VSEs. Moreover, a rigorous literature review on mobile systems architectures and mobile application development approaches was carried out to discover the best frugal way of developing the solution. In particular, the IS solution applied the three-tier layered architecture (presentation layer, application layer, data layer) as shown in Figure 3.3. The three-tier architecture of the system is lightweight mobile web-based client/server architecture (Gruhn and Kohler 2007), where the presentation layer is realized on the client side and the application layer together with the data layer is realized on the server side. The choice of the architecture was primarily governed by the aforementioned frugal information drives, along with their potential technological candidates that promise to fulfil them. In addition, factors such as purpose of the solution, nature of the system distribution, point of service, source code redundancy, and security were considered during the process of selecting the system architecture. The system architecture of the IS solution

supports a wide range of VSE mobile systems irrespective of their underlying mobile platform and other client side conditions. It also encourages a consistent, unified and standard look-and-feel across different mobile platforms.

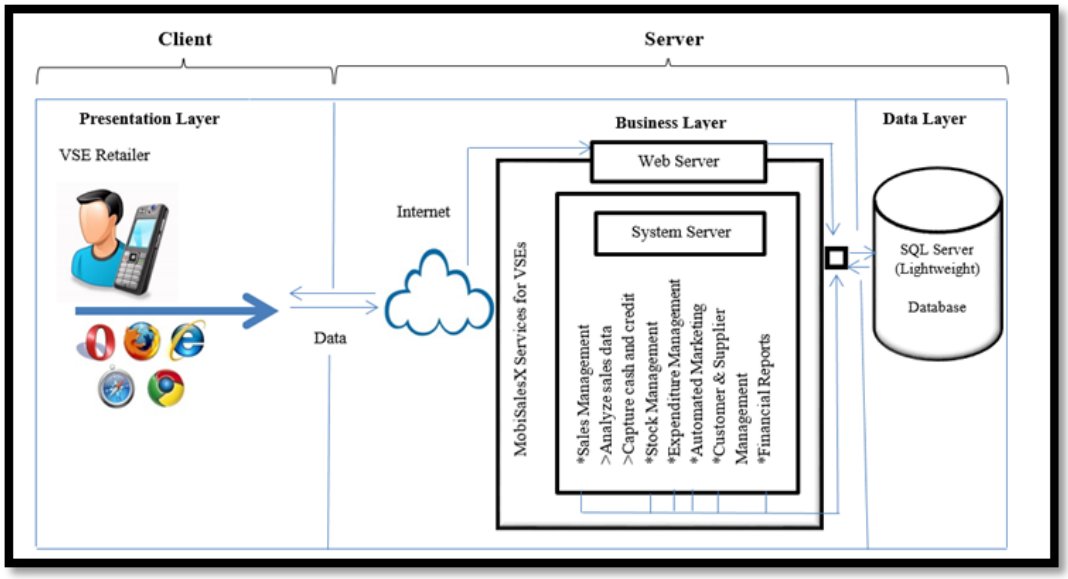

Figure 3.3: MobiSalesX web-based system architecture

In the above architecture, the VSE Retailer can use any mobile web browser (internet explorer, chrome, opera, safari) embedded on his/her mobile device, regardless of the underlying mobile platform to access the UI of the system. Briefly, the VSE Retailer makes a request, via the internet, using a standard URL, to the system back-end server, which subsequently delivers the UI of the system back to the client, through a mobile web browser. The back-end server is the main service domain which is typically hosted in the cloud environment on top of powerful data centre layers to deliver high-performance service to VSEs who are often concerned with efficiency in their business. The process of accessing MobiSalesX system merely involves a simple function of logging onto the system using valid user credentials which then gives VSEs access to their business. The services of MobiSalesX are accessed anywhere and anytime, through a UI in the web browser on any compatible mobile client device that has access to the internet. The basic enterprise services that are delivered to VSEs include sales management, stock management, customer relationship management, and financial reporting. These services are offered to VSEs at a low level that suits their business context.

In the aspect of coding, ASP.NET MVC 5 was employed as the web development framework and Microsoft Visual Studio was utilized as the default integrated development environment (IDE). The client-side of the system is developed with technologies such as

HTML5, JavaScript, CSS and Bootstrap framework. These relevant and lightweight technologies were excellent candidates for structuring a responsive IS solution that supports cross platform and cross-browser compatibility. In addition, they presented an enticing and a user friendly UI system. The server-side of the system was developed using the C# programming language. The technologies such as Language-Integrated Query (LINQ) and Microsoft SQL Server Express were explored. The Microsoft SQL Server Express was preferred because it is powerful at delivering rich and reliable data store for lightweight web based applications and works well across a variety of devices and data sources such as desktops, mobile phones, and tablets (Mistry and Misner 2012).

The entire development process focused on designing a quality IS solution that supports reusability and maintainability at low cost and effort while meeting the business needs of VSEs. Chapter 4 of this dissertation explains the development of the MobiSalesX system in detail. The MobiSalesX system prototype was deployed through Microsoft Azure free trial account for the purpose of testing and evaluation. The process of testing and evaluation were linked with the two activities of DSRM namely, demonstration and evaluation.

3.2.3.3. **Evolution Process**

The evolution process includes deployment, maintenance and evolution. Once the production version of MobiSalesX system has been deployed, after fixing all the issues that arose during evaluation and maintenance it can be considered based on the VSEs demands. Thanks to the iterative strength of the adopted web-based application development model which promotes flexibility of moving back into the development process. However, the same is also achieved in DSRM in the evolutionary activity. The IS solution developed in the research study was designed to adapt to future requirements and support maintainability. The system design has low complexity which means the maintenance could be done at low cost and effort. In addition, it is foreseen that the changes in MobiSalesX system will be minimal and not fundamental.

In respect to evolution, Huang *et al*. (2010) state that “evolution branches out from the maintenance step, at which a decision is made whether to “repair”, “evolve or re-engineer” the existing application”.

3.2.4. **Demonstration**

The demonstration of the MobiSalesX prototype system is illustrated in Chapter 4 of this dissertation. The system is demonstrated in the form of screenshots. According to Peffers *et al.* (2008), the demonstration should clearly show how the artefact addresses some instances of the problem. In the case of this study, the demonstration of the MobiSalesX prototype system does not only illustrate how the artefact solved the business problem of VSEs, but it also demonstrates the improvements that are considered vital for the survival of VSEs. Moreover, a discussion of how the system satisfied the four information drives of frugal IS is provided. The entire demonstration was viewed, considering the adopted development model as the testing phase to a certain extent because during this process the solution was being tested against the needs of VSEs.

3.2.5. **Evaluation**

The fifth activity of DSRM model requires the artefact to be evaluated comprehensively because evaluation is a vital part of DSR (Peffers *et al.*, 2012; Hevner *et al*., 2004). There are a good number of evaluation methods that are commonly used to assess IS solutions which are outlined in the study of Peffers *et al.* (2012). However, the evaluation methods which were used in this dissertation were not selected on the basis of popularity, but they were thoroughly studied and selected based on their robustness and suitability. The ADVIAN classification method (Linss and Fried 2010; Linss and Fried 2009) was used to assess the complexity in the design of MobiSalesX system. The usability of the system was evaluated using a field-based evaluation method; in particular, usability focus groups and questionnaires were used (Beckert *et al*., 2014; Mazza and Berre 2007). The entire evaluation process and discussion of results are addressed in Chapter 5 of this dissertation. The prominence of the evaluation lies in demonstrating that the MobiSalesX prototype system that was developed, by following DSR and adopting a novel life cycle model for web-based application development, met its goal and achieved its desired benefits.

3.2.6. **Communication**

The final activity of DSRM focuses on communicating the problem that was addressed in the research, its importance and how well the proposed system solved it (Peffers *et al.*, 2008). This activity involves stating clearly how the overall objectives of the research study were achieved. This dissertation, as a Master's Degree project, can be regarded as a piece of communication that lucidly discusses the business problem of VSEs and how an artefact

called MobiSalesX system has addressed it. This piece targeted the academic audience. The academic journal paper that is currently in progress, as a result of this research study, is targeting academic journals such as *The Electronic Journal of Information Systems in Developing Countries*, *The South African Journal of Information Management* and *The African Journal of Information Systems.*

3.3 **Suitability of Research Methodology**

The literature states that there's no better methodology for conducting a DSR based study, especially in the IS discipline. However, Peffers *et al.* (2008) posits that the DSRM suggests a good way of doing a DSR in the IS discipline. In this section, the suitability of DSRM for study is validated using the seven guidelines of DSR suggested by Hevner *et al.* (2004).

3.3.1. **Design as an Artefact**

Guideline 1 emphasizes that the product of DSR should be an artefact classified as a construct, a model, a method, or an instantiation. A technology-based system that overall aims to change the current situation of VSEs to a more preferred one was actualized. This artefact can be classified as an instantiation. As stated by Hevner *et al.* (2004), an instantiation is "a type of system solution". The MobiSalesX system is a web-based frugal IS solution that is specifically developed for VSEs. The system was designed and developed using the existing knowledge of literature, creativity and problem solving acumen of the researcher.

3.3.2. **Problem Relevance**

Hevner *et al.* (2004) state that DSR in IS should be centred on acquiring knowledge, understanding and transforming that to a technology-based solution that eventually solves an important business problem. The output of this research addresses a critical business problem of lack of financial management identified among VSEs. The MobiSalesX system, which is the final research output, is at the core of IS but the solution is also relevant in the accounting management discipline because it deals with capturing, maintaining and analysing business transactions of VSEs.

3.3.3. **Design Evaluation**

Evaluation is a crucial component of a research process. There are two objectives of this dissertation which are centred on evaluation: ii) to evaluate the design complexity of a mobile web-based frugal IS, and iv) to evaluate the usability of the developed mobile web-based frugal IS in the environment of VSEs. The ADVIAN method was explored for addressing objective ii) and a field-based evaluation method was employed for addressing objective iv).

3.3.4. **Research Contribution**

According to Hevner *et al.* (2004), a DSR oriented study can contribute one or more of the following: a design artefact, a foundation, or a methodology. The contributions of the research reported in this dissertation have been explicitly enunciated in Chapter 1.

3.3.5. **Research Rigor**

Hevner *et al.* (2004) recommends that rigorous methods need to be applied during the stage design and evaluation of the artefact. The design and development of the IS solution is documented detailed in Chapter 4 of this dissertation. The development of the solution was based on sound and relevant knowledge obtained through review of relevant and recent literature. The evaluation methods that were used during the evaluation of the system were suitable and satisfactory.

3.3.6. **Design as a Search Process**

Hevner *et al.* (2004) write that "design is essentially a search process to discover an effective solution to a problem". Chapter 2 of this dissertation, which is a literature review, served as a tool for searching knowledge that informed the design of the solution. Additionally, the VSEs were visited to search for and collect data that indirectly contributed in finding the most optimal solution of their business problem.

3.3.7. **Communication**

Hevner *et al.* (2004) propound that DSR must be presented effectively both to technology-oriented as well as management-oriented audiences. The output of this research is relevant to both technologies-oriented and management-oriented audience. For technology-oriented audience, the development of the IS solution and the evaluation process is discussed in Chapter 4 and 5, respectively. For management-oriented audience, the problem of poor financial management amongst VSEs is enunciated in Chapter 1. The suitability of the

developed IS solutions for managing business information of VSEs is elucidated in Chapter 4. The functions of the MobiSalesX prototype system are described and demonstrated, to bring the management-oriented audience on board. Since this research is a Master's Degree project, this dissertation is the main piece of communication targeting both audiences.

3.4. Conclusion

This chapter explained the IS research methodology that was employed to conduct and present a DSR oriented study. Firstly, the chapter presented a DSR paradigm, which was deemed as the most suitable and relevant IS paradigm for the research study. Additionally, the choice of selecting this paradigm was justified through highlighting some profound reasons mined from the literature. Secondly, this chapter described in detail how the DSRM was applied in relevance to the entire research process. A novel life cycle model for web-based application development was tied to the DSRM, specifically for the purpose of developing a quality web application within limited resources and time. Finally, the methodology that served the research study was evaluated using the seven guidelines of DSR. The next chapter discusses the development of the MobiSalesX prototype system and demonstrates its utility.

CHAPTER 4: DEVELOPMENT OF MOBISALESX

This chapter presents the development of MobiSalesX system, a mobile web-based frugal IS that essentially supports VSE business transactions. In this study, the purpose of development is to legitimize the proposed frugal IS and demonstrate a proof-of-concept prototype which is a paramount part of DSR. The system which is being developed is viewed as an improved version of the existing system of VSEs and this proceed is pertinent to DSR. This chapter is structured as follows. Section 4.1 discusses the business and user requirements of VSEs. Section 4.2 expresses the functional specifications for the final solution, and lists the artefacts that make up the specifications. Section 4.3 and Section 4.5 describes the development of the prototype system interface and the implementation of the prototype system. Section 4.6 demonstrates how the prototype system works. The system is a mobile web-based frugal IS which can be accessed through a web browser on any mobile device such as mobile phones, smartphones, or tablets that has access to the internet.

4.1. Requirements of VSE System

There are various types of requirements that are involved in the process of developing a new system or improving on an existing one. Business requirements are one of the essential requirements that are of high importance when developing an IS solution. Business requirements represent the top of the requirements chain and they define the vision of the solution and the value that it will deliver to the targeted audience (Wiegers and Beatty 2013). Selioukova (2002) highlights that all other requirements must be aligned with the business requirements. According to Wiegers and Beatty (2013) there are three distinct levels of software requirements which are worth to be considered when developing an IS solution: business requirements, user requirements, and functional requirements. Generally speaking, business and user requirements are used to derive the features or functions of a new system. The literature reveals that in order to develop a successful IS solution, it is pivotal to comprehend user requirements (Maguire and Bevan 2002; Butkiene and Butleris 2001), and bring them in line with business requirements.

There were two methods which were employed, in a complementary manner, to gather both business and user requirements of VSEs, namely, contextual inquiry method (Holtzblatt and Beyer 2013) and document analysis method (Wiegers and Beatty 2013). The contextual inquiry method took on a direct approach while the document analysis method

took on an indirect approach. Consequently, the following business requirements were established:

i) To implement an IS that automates previously manual business tasks of VSEs.
ii) To provide a mechanism of increasing sales to existing customers.
iii) To increase business efficiency and profitability.
iv) To integrate business processes and information.
v) To prevent fraud and theft.

Of course, there were conflicts among VSEs during the process of establishing the above listed business requirements; however, the researcher facilitated a conflict resolution that fitted well with suggestions that are maintained in the literature concerning requirements elicitation and subsequently a consensus was reached. In addition, the existing literature on VSEs was reviewed with the objective of deducing other potential business requirements that could help in delivering maximum business value in this sector. The process of user requirements elicitation provided a comprehensive understanding of different tasks that VSEs intended to perform with the IS solution that was proposed and the non-functional characteristics that were germane to them. Yet, it was discovered that though they utterly understood their business, but some VSE's could not clearly describe their business needs and, as a result, had a blur idea of what they would desire to do with the solution. Nonetheless, other user requirements were concluded through analysing the existing documentation of current IS solutions, specifically looking at topics that deal with requirement engineering and business process modelling for small businesses. Maguire and Bevan (2002) state that during this method of analysing existing documentation, useful features that are identified need to be fused into the design process as potential user requirements of the proposed solution. In fact, this technique is suggested in a number of studies, including Wiegers and Beatty (2013) and Zowghi and Coulin (2005).

Table 4 below presents the significant user requirements that were congregated for developing the proposed IS solution for VSEs. The table is presented in the following format. **ID**: holds the identification number for each user requirement. **Description**: presents the actual user requirement. **Priority**: is the degree of necessity of a user requirement. The user requirements are categorized based on their priorities which are essential, desirable and optional.

Table 4.1: User requirements of VSEs

ID	UR Description	Priority
UR1	The users shall be able to access their business financial reports, namely, sales and expenditure, profit and loss, and cash flow, preferably on daily or weekly or monthly basis	Essential
UR2	The users shall be able to capture cash and credit sales business transactions at any time.	Essential
UR3	The users shall be able to market new products and special offers to existing customers	Desirable
UR4	The users shall be able to capture business expenditure transactions at any time.	Essential
UR5	The users shall be able to view customers who are owing and those who have paid.	Essential
UR6	The users shall be able to mark and trace products/goods that are returned by customers.	Desirable
UR7	The users shall be able to capture and manage inventory goods	Essential
UR8	The users shall be able to get continuous notifications concerning the inventory goods that are running low in quantity.	Essential
UR9	The users shall be able to attach a copy of invoice or (receipt) for all expenditure transactions.	Desirable
UR10	The users shall be able to view their business financial reports in PDF or Word format.	Essential
UR11	The users shall be able to easily access information about what is possible with the system and what is not.	Optional
UR12	The users shall be able to manage customers and suppliers' information.	Desirable

UR13	The users shall be able to communicate efficiently with customers and suppliers concerning business orders.	Essential
UR14	The users shall be able to visual the location of existing customers.	Desirable
UR15	The users shall be able to use mobile money services to make payments for expenditure transactions such as rental, suppliers and salary or wage.	Desirable

A prototyping method (Asim and Sahar 2009) was used to validate and refine the user requirements of VSEs. A paper-based prototype included elements such as menu, icons, buttons and navigations, which made it easy for VSEs to critique and provide positive feedback. Consequently, the user requirements of VSEs were coherently synergized, after being fine-tuned, and the design goal was recognized. The user requirements that informed the design of the IS solution for VSEs were complete, unambiguous, testable, and traceable. Both, the business and user requirements that were gathered from VSE were then transformed into functional specifications. The transformation of requirements into functional specifications was a shift from problem definition to solution design. This transformation included describing the functionalities that the system should provide and the services that it will offer to the VSEs.

4.2. **Functional Specifications of MobiSalesX Systems using UML/OCL**

The desired behaviour of the proposed system can be expressed in terms of functions, tasks or services (Malan and Bredemeyer 2001). The proposed IS for VSEs is presented in terms of functions which illustrate what the system is required to do. Since the paradigm that is being followed in this dissertation does not dictate any modeling techniques, it was decided that the functions of the proposed system would be modeled using UML/OCL. The researcher decided to use UML because it is a standard modeling language that allows for specifying, visualizing, constructing, and documenting IS; while OCL was considered to complement the information of UML models (Cabot and Gobolla 2012). OCL is a formal specification language of typed expressions that is mostly used for specifying constraints or queries for the system that is being modelled (Demuth 2009; Cariou *et al*., 2004). Bajwa *et al*. (2010) maintain that "OCL can be used as part of UML model to significantly improve the clarity of software models and make models more precise". The UML models which were considered

for modelling the functions of the system are: use case diagram, system sequence diagram, and class diagram. These UML models were essential because they enable static modelling and dynamic modelling. The UML use case diagram is an appropriate mechanism for presenting the functional requirements of a system from a user perspective (Bruegge and Dutoit 2010). It explicitly presents how an external actor interacts with the system under consideration to achieve a particular goal. The UML system sequence diagram models the dynamic behaviour of the system and it is very useful for identifying additional objects that participates in use cases. The class diagram is a high level conceptual meta-model that describes the type of object classes, attributes, operations, and various kinds of static relationships that exist in a system (Bruegge and Dutoit 2010). However, UML class diagrams are not sufficient enough to provide all relevant domain information (Cabot and Gogolla 2012; Roe *et al*., 2003). Thanks to OCL which augments the UML models, especially on the class diagram, to produce an unambiguous and precise system description. In this dissertation, it was considered frivolous to create a complete set of analytical models of the entire system; rather, the focus was directed at modelling the parts of the system that are complex, risky and subjected to ambiguity.

4.2.1. **Use Case Diagram of MobiSalesX System**

Figure 4.1 depicts a use case diagram that shows the interaction that is expected to take place between the actors and commands of the MobiSalesX system. This provides a coherent unit of functionality that is provided by the MobiSalesX prototype system (Merseguer and Campos, 2003). The dependencies between use cases, expressed through «extends» and «includes» are essential because they clarify the relationships that exist, which in return help to eliminate ambiguity in the system. The «extends» use case represents optional behaviour while the «includes» use case represents mandatory behaviour.

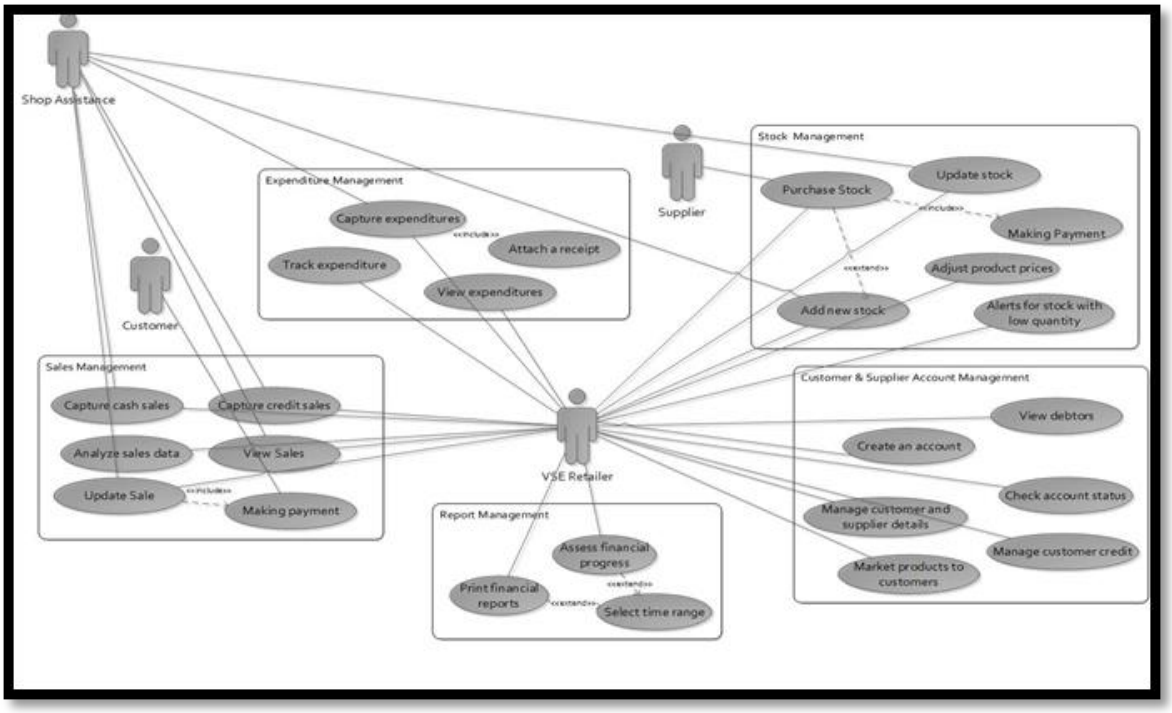

Figure 4.1: Use Case Diagram for MobiSalesX system

Table 4.2 shows the actors that interact with the system and their roles. An actor may also be identified with a role it plays rather than by its name, with respect to a given use case (Wegmann and Genilloud 2000). It is important to note that the focus was devoted to the VSE Retailer because it is the main target user of MobiSalesX system.

Table 4.2: Roles of different actors in MobiSalesX

Actors	Roles
Customer	The customer is registered with a particular VSE retailer and buys VSE goods through cash and credit and also places orders.
VSE Retailer	The VSE retailer deals with all business functions, from capturing business transactions to assessing financial reports.
Shop Assistance	The shop assistance performs basic business functions and has limited access to other system functions.
Supplier	The supplier is registered with a particular VSE retailer and delivers ordered stock goods to the VSE retailer.

4.2.2. **System Sequence Diagrams of MobiSalesX System**

Alhumaidan (2012) states that a system sequence diagram is a convenient modelling tool because it provides a dynamic view of system showing behaviour which is not possible to realize from statics of the system. The UML sequence diagram illustrates a set of objects that are involved in one particular scenario of a use case and the sequence of activities that are triggered. The interactions between the system and the actors were kept at minimal, especially when it comes to the aspect of capturing business transactions. This was done purposefully in order to assist VSEs to perform their business tasks faster and easier; as a result, promoting efficiency. Figure 4.2 is a sequence diagram that illustrates the sequence of activities and objects that are involved when an expenditure transaction is being captured into the system. The registered VSE retailer needs to login in order to utilize the services that are provided by the system. The system renders a login view; and after the VSE Retailer has captured his login credentials, the system performs the necessary validations before redirecting the user to the main menu. The VSE retailer opens an Expenditurelog where all business expenditure transactions are captured. Thereafter, he captures the required values in the relevant client controls, including an image copy of a receipt or invoice. The system keeps image copies of receipts or invoices to substantiate the authenticity of the transaction and to control fraudulent practices amongst VSEs. Parry (2009) highlights that an image is more effective at conveying information than its verbal and written counterparts alone.

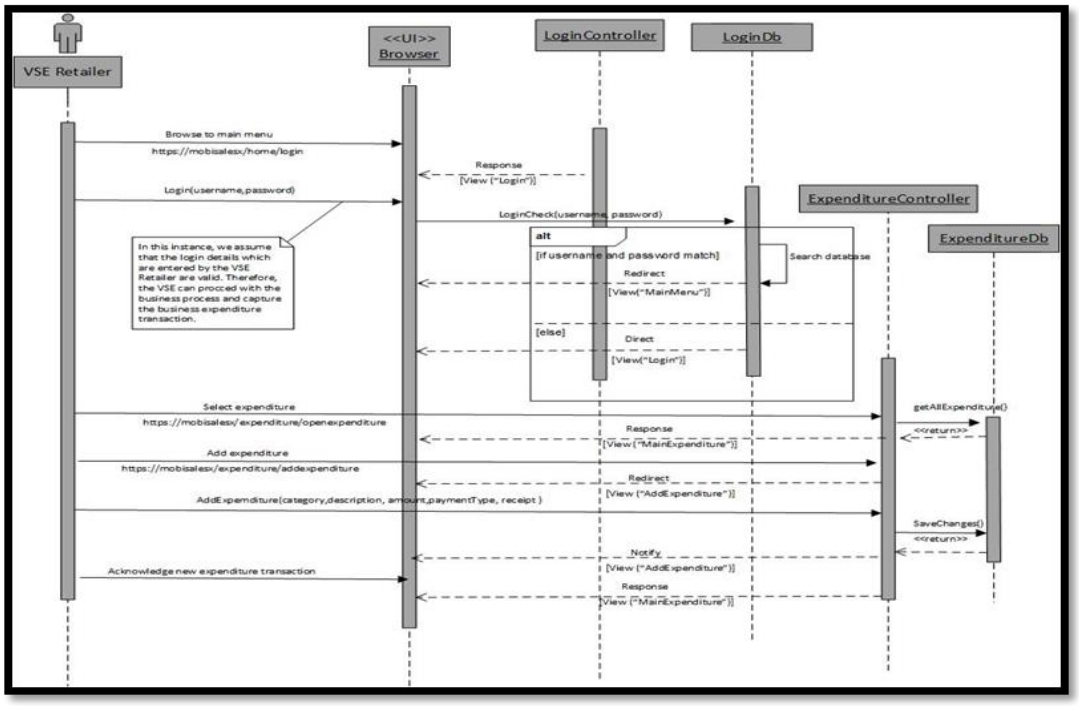

Figure 4.2: UML sequence diagram for capturing VSE expenditures

Figure 4.3 demonstrates a UML sequence diagram which shows the sequence of activities that are involved to realize the "capture credit sale" use case. In this sequence, the VSE retailer indicates that he wants to add a new sale transaction by opening a Saleslog on the system main menu. Consequently, the Saleslog is returned and the VSE retailer captures the required values on relevant input fields, after clicking Add Sale. The system then performs the necessary validations and arithmetic calculations to get the amount due for the sale. At the end, the system returns a notification, which is intended for the customer, regarding the status of the transaction which may include the amount due and payment due date. The Customer acknowledges this information and the VSE Retailer ends the sale. The Saleslog allows VSEs to record different types of sales business transactions such as cash sales and credit sales.

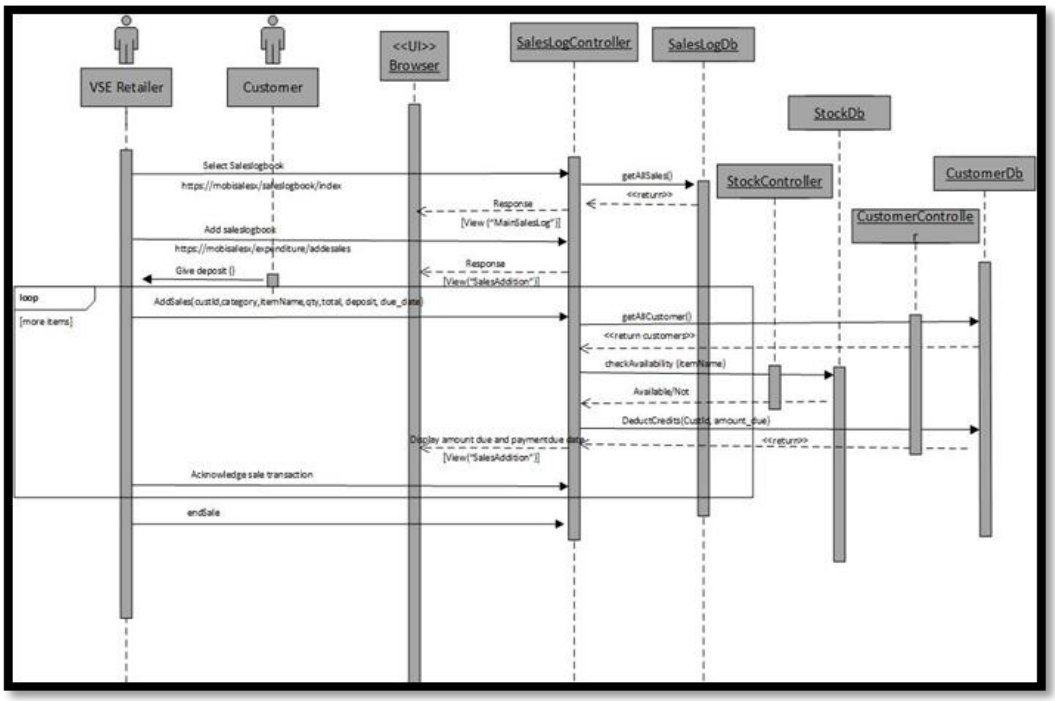

Figure 4.3: UML sequence diagram for capturing customer credit sale transactions

Figure 4.4 depicts a UML sequence diagram which demonstrates the flow of logic as the system is in operation to market a specific product to a customer using SMS technology. Certainly, to make use of SMS technology in MobiSalesX, a reliable SMS gateway RESTful application programming interface (API) had to be considered. Through the main menu, the VSE Retailer designates that he wishes to market his product and subsequently a view that supports this use case scenario is rendered. Simultaneously, the customer's details and product details are retrieved from the database. Thereafter, the VSE Retailer may choose to briefly personalize the predefined marketing, SMS for VSEs to enhance customer experience. The system implements the necessary validations and, if there are no errors found, the SMS is

sent to the customer and the VSE Retailer acknowledges this message. Takhar *et al*. (2013) argue that SMS marketing is cost effective and it can assist VSEs to survive and grow their businesses.

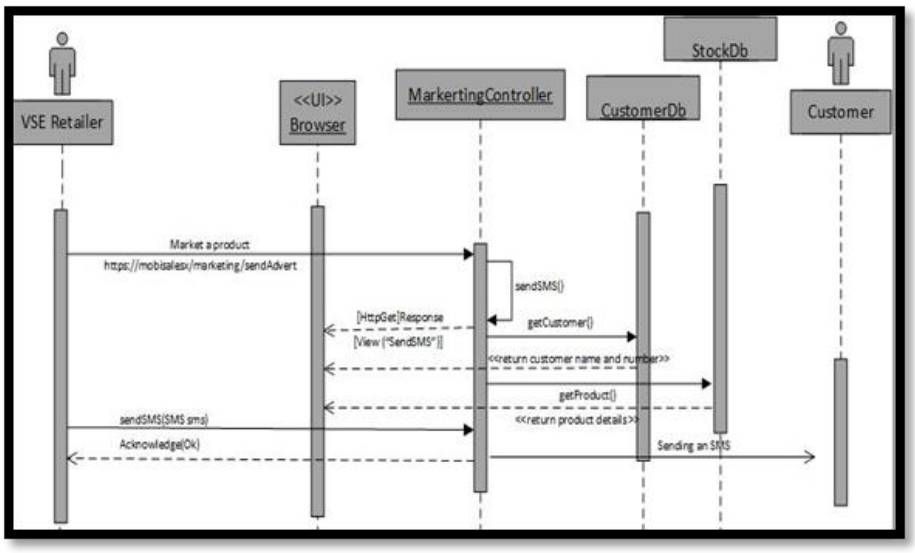

Figure 4.4: UML sequence diagram for marketing a product to a customer

4.2.3. **High Level Conceptual Meta-Model (Class Diagram)**

The UML models that were produced were thoroughly analysed to design a high level conceptual meta-model that describes the type of object classes, attributes, and operations that are needed in the system (Bruegge and Dutoit 2010). Figure 4.5 presents controller classes which are responsible for handling the flow of the entire system operations. These classes are crucial because they act as the heart of the system (Freeman, 2016).

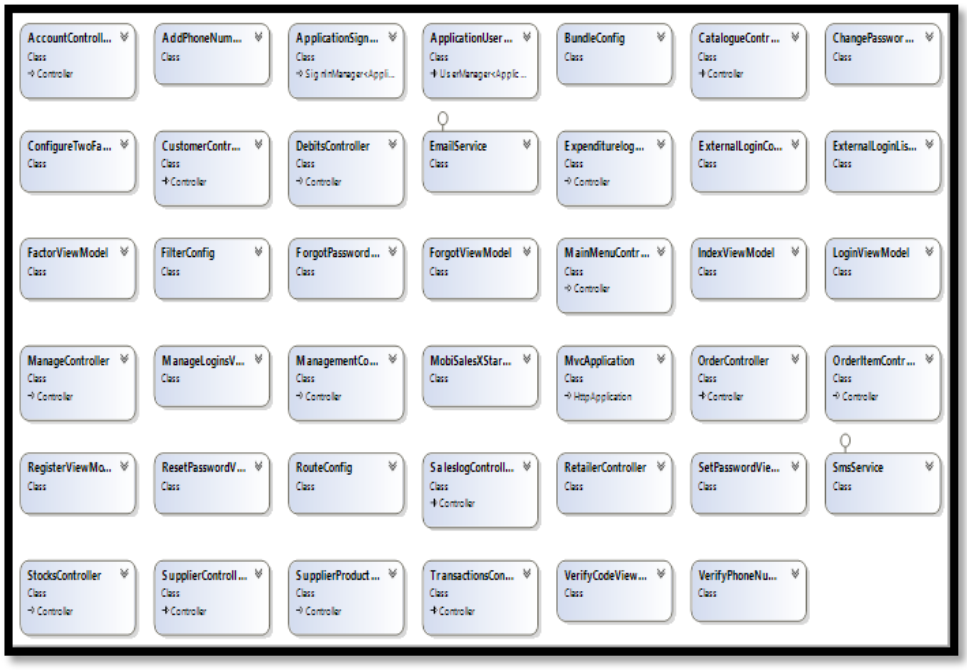

Figure 4.5: Controller classes of MobiSalesX system

The analysis revealed that there are ten main object classes which are paramount in the business processes of VSEs: *User, Retailer, Supplier, Customer, Saleslog, Credit, Cash, Stock, Expenditurelog, and Catalogue.* Figure 4.6 presents these ten entities or model classes that were of considered importance in order to encode the system. The model below exhibits some important elements of object oriented design such as inheritance, aggregation and association which were part of the system design. The actual implementation of the system database is based on this model.

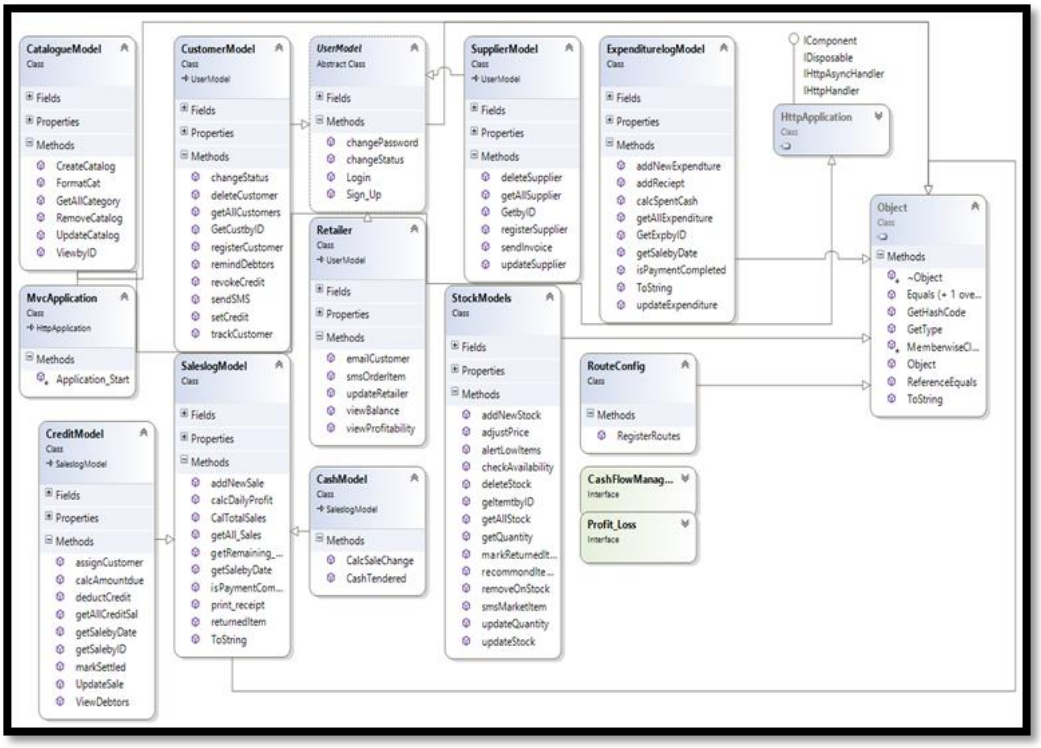

Figure 4.6: Design class diagram for supporting business processes of VSEs

4.2.4. **OCL Expressions for MobiSalesX**

OCL was used in conjunction with UML class diagram metal-model to overcome the limitations that are presented by the UML models when it comes to specifying detailed aspect of a system design (Cabot and Gobolla 2012). The above class diagram may house the complete scope of the problem but there are other details that are not addressed. In this study, OCL is used to specify invariant constraints and to describe operation contracts. The OCL invariant constraint is a state condition that needs to be satisfied by all instances of a context type (object class). The invariant constraints ensure system design integrity. For operation contracts, a declarative approach was used, which comprise of *pre* and *post* condition (Cabot and Gobolla 2012). The pre-condition of OCL class states some constraints that need to be true before the execution of an operation. The post-condition of OCL class states the conditions that must be true just after the operation has been executed. The stereotypes of constraints are shown as follows: **"inv:"** for invariant constraint, **"pre:"** for pre-condition and **"post:"** for post-condition. The following OCL expressions represent some design aspect of the MobiSalesX system.

i) **UserModel**

a) It expresses that in order to register a customer; there should be no existing record that matches the particulars of the customer to be registered. Once the customer has been registered, his personal details should be accessible in the system.

Context *User:registerUser (c: Customer)*

pre: not *customers -> include (c)*

post: *-> size (customers**@pre**)+ 1*

post: *customers -> include (c)*

[---**@pre** denotes the previous value that was held by that property.]

b) It expresses that each user identification number shall be unique.

Context *User* ***inv:****Users.allInstances - >isUnique(UserID)*

a. [---**'context'** refers to the classifier; it can be set to any model element, such as class, interface, package or sub elements such as operation]

c) It implies that no user can share the same identity. This condition must hold for all instances of customer, supplier and retailer.

Context *UserModel* ***inv****: CustomerModel ->forAll(c1, c2| c1 <> c2 implies c1.custID<>c2.custID)*

Context *UserModel* ***inv****: SupplierModel ->forAll(s1, s2| s1 <> s2 implies s1.supplierID<>c2. supplierID)*

Context *UserModel* ***inv****: RetailerModel ->forAll(r1, r2| r1 <> r2 implies r1.retailerID<>c2. retailerID)*

d) It describes the state of the system when the VSE retailer updates a particular record of a customer.

Context *User::updateUser(custID:Integer, category:String)*

pre: not *customers -> isEmpty()*

pre : *customers -> exist(u : User | u.userID=custID and u.Category=category)*

post: *customers ->one(userID =custID)*

ii) **<u>StockModel</u>**

a) It expresses how a new stock item is added to the MobiSalesX system

Context *Stock::addNewStock(itemName:string, description:string, quantity:int, price:float, category:string,image:Image,stockDate:Date)*

pre :*stockdate>expDate*

post :*Stock.allInstances->one(s |s.oclNew() and s.oclTypeOf(Stock) and s.name=itemName and s.description=description and s.image=image and s.category=category and s.price=price and s.quantity=quantity and s.stockdate=Date)*

post :*itemID.oclIsNew*

b) It indicates that the price for all product items in stock must always hold a positive value.

Context *Retailer* ***inv****: self.stock->forAll(price>0)*

c) It implies that when a particular stock item quantity reaches a predefined threshold, the MobiSalesX system notifies the VSE retailer to make orders.

Context *Stock::alertLowItems()*

pre :*self.quantity<=10*

post : *-- a notification is sent to VSE Retailer.*

d) It expresses how a stock item quantity is updated.

Context *Retailer::updateQuantity(itemID:Integer)*

pre : *stock->includes(itemID=itemID)->size()=1*

post:*self.quantity=quantity****@pre****+q*

[--- q holds the value of quantity which added into stock]

e) This expression indicates how expired stock can be removed in the system.

Context *Stock::removeOnStock(itemID:Integer)*

pre : not *stocks. isEmpty()*

pre : *stocks->includes(itemID=itemID)->size()=1*

post :*stocks->excluding(itemID)*

iii) **SaleslogModel**

a) It describes a new sale transaction is added. In this instance, a cash sales transaction is being captured.

Context *Saleslog ::addNewSales(itemID:String, category:String, descript:String, quantity:Integer, cost: float, cashTend:float, salesDate:Date,)*

pre: *stock->any(itemID=itemID)->size() =1*

post : *Saleslog .allInstances->one(slog | slog.oclIsNew() and slog.oclIsTypeOf(Saleslog) and slog.descriptioin=descript and slog.quantity = quantity and slog.cost =cost and slog.cashTend=amountTendered and slog.saledate=salesDate)*

post :*salesID.oclIsNew()*

b) This expression indicates that for a credit sale, a sale due should always date an up-coming date.

Context *Credit* ***inv*** *#TransDate:*

self. salesDate<self.salesDueDate

iv) **ExpenditurelogModel**

a) It describes how an expenditure record is removed in the system**.**

Context *Expenditurelog::removeExpenditure(expenditureID:Interger):*

pre :not *Expenditurelogs.isEmpty()*

post :not *expenditureID.oclIsIsNew()*

b) This expression implies that the VSE Retailer can filter or view all expenditure transactions using a specific date.

Context *Expenditurelog::viewEpenditure(date:Date):*

pre :not *Expenditurelogs ->isEmpty()*

pre : *date<=today and date<>null*

post : *collection(Expenditurelogs)->forAll(s| s.TransactionDate = date)*

v) **CatalogueModel**

a) It describes how a catalogue is created. A catalogue holds information about different stock items.

Context *Catalogue::createCatalogue(s:Stock)*

pre :not *catalogue -> include (s)*

post:*catalogue-> size (catalogue****@pre****)+ 1*

post : *catalogue -> include (s)*

b) This expression indicates how customers can view items available on the VSEs catalogue

Context *Customer. Catalogue::viewCatalogue():*

pre :not *catalogue->isEmpty()*

post : *collection(catalogue)->size>0*

4.3. **Design Architecture of MobiSalesX System**

The three-tier architecture (Al-Mukhtar and Hadi 2012; Kambalyal 2010) was followed in the design of MobiSalesX system. This web-based client-server architecture was selected based on the philosophy of separation of concerns which is the main principle of software engineering (Habra 2001). In addition, this architecture supports scalability, reliability, flexibility and reusability. The MobiSalesX system is structured and decomposed accordingly: presentation layer, logic layer and data layer. The MVC architectural pattern is used, in a complementary manner, to support a strong separation of concerns. The presentation layer is split into controllers and views. The controllers call the logic layer, and the logic layer calls the data layer. Most system components of MobiSalesX are deployed in the logic layer which is composed of essential domain entities and encapsulates different computational logic. The system is hosted in the cloud environment on various interconnected web servers which act as one server to provide high service performance to different VSEs, and to ensure that services of MobiSalesX are readily accessible at anytime and anywhere. The data layer is responsible for saving, analysing, and retrieving VSE business data in the server.

4.4. **MobiSalesX User Interface Design**

This section describes the concepts related with the design of the UI for MobiSalesX. The MobiSalesX system is a mobile web-based frugal IS that utilizes a web browser to interact with its VSEs. Considering that most contemporary computing devices such as mobile phones, tables, and laptops come with a web browser; the system is potentially accessible through any device. This unrestricted accessibility of MobiSalesX does not force VSEs to use certain medium that fulfils certain requirements in order to access the system. This design fulfils the information drive of universality which focuses on utilizing whatever resource that the target audience is likely to have, to avoid system incompatibility (Watson *et al.*, 2013). This means that MobiSalesX is potentially a multimedia system that satisfies different screen resolutions through responsive web design (RWD). The RWD is a technique of making web-based system easily viewed and used on any type of device and size of screen (Peterson, 2014). A flexible grid layout was also used to address the issue of different screen orientations, especially for smaller mobile devices, such that the system adapts to the constraints of the device or the browser that VSEs uses to access the system. For mobile devices with low screen resolution and insufficient space to house and display the system

menu items, a solution of temporary hiding menu items and presenting a button to toggle its visibility was considered. This promised to maintain a good user experience as VSEs could only access menu items when they needed. In addition, consistency was maintained in the UI design elements to further improve user experience and ease of use.

4.5. Implementation of MobiSalesX Prototype System

The prime aim of this research was to implement a frugal IS that supports VSE business transactions. This aim carried the potential of helping VSEs to improve their financial management which has a positive impact on the business performance. The implementation of MobiSalesX followed a novel life cycle model for web-based applications development (Huang *et al*., 2010) and applied the concept of frugal IS (Watson *et al.*, 2013) to address the issue of resource scarcity amongst VSEs. The implementation of the system employed ASP.NET MVC5 as the web development framework. ASP.NET MVC5 "is a framework for building web applications or systems that applies the general MVC pattern to the ASP.NET framework "(Galloway *et al*., 2014). MVC is a powerful and significant architectural design pattern which promotes separation of concerns by separating the UI of an application into three aspects: Model, View and Controller (Kojic 2014; Galloway *et al*., 2014).The ASP.NET MVC5 release includes distinct features such as Bootstrap templates, Filter overrides, Attribute Routing, ASP.NET Scaffolding, Authentication Filters, ASP.NET Identify and many other cool features that make this framework a special candidate for developing the system of VSEs. Given that the architectural design of MobiSalesX is mobile web-based client-server architecture, it involves development for both sides (client-side and server-side). The client-side (front-end) of MobiSalesX mainly contains a web browser and it was developed primarily with web technologies such as HTML5, CSS, JQuery, and Bootstrap.

HTML5 is the latest standard markup language for structuring and presenting web-based content that is supported by most web browsers. This technology is an excellent candidate for developing the UI of MobiSalesX because it presents interesting features such as new semantic elements and geolocation API which are solely based on HTML, CSS, and JavaScript (Clark *et al.*, 2012). JavaScript is another lightweight programming language that is open and cross platform which was integrated with HTML5 to bring a dynamic behaviour to the HTML content of the system. One of many merits of using JavaScript include less interaction with the server since user input validation is performed on the client-side; hence

improving data integrity. Bootstrap was also used in the front-end of the system. Bootstrap is a “sleek, intuitive, and powerful mobile first front-end framework for faster and easier web development” (TutorialsPoint 2014). This recent technology uses web technologies and it includes support for RWD, and this fitted well with MobiSalesX system which aims at different mobile device types with different mobile screen size. The client side and server side of the system uses HTTP as the standard protocol for exchanging requests and responses (Rewatkar and Lanjewar 2010). The user inputs are viewed as HTTP requests that are sent from client web browsers in a form of the URL request. This URL request follows the following pattern: “*http://domain/{controller}/{action}/{parameters}.* The HTTP requests are routed to the *Controller* class, where it finds the appropriate action method to implement based on the pattern. Figure 4.7 shows the ExpenditureLogController class that maps the URL to the action methods in the class.

```
using System.Web.Mvc;
using MobiSalesXPrototype.Models;

namespace MobiSalesXPrototype.Controllers
{
    0 references
    public class ExpenditureLogModelsController : Controller
    {
        private MobiSalesXPrototypeContext db = new MobiSalesXPrototypeContext();

        // GET: ExpenditureLogModels
        0 references
        public ActionResult Index()
        {
            return View(db.ExpenditureLogModels.ToList());
        }

        // GET: ExpenditureLogModels/Details/5
        0 references
        public ActionResult Details(int? id)
        {
            if (id == null)
            {
                return new HttpStatusCodeResult(HttpStatusCode.BadRequest);
            }
            ExpenditureLogModel expenditureLogModel = db.ExpenditureLogModels.Find(id);
            if (expenditureLogModel == null)
            {
                return HttpNotFound();
            }
            return View(expenditureLogModel);
        }

        // GET: ExpenditureLogModels/Create
        0 references
        public ActionResult Create()
        {
            return View();
        }

        // POST: ExpenditureLogModels/Create
        // To protect from overposting attacks, please enable the specific properties you want t
```

Figure 4.7: Code snippet of the ExpenditurelogmodelsController class

Depending on the request type (GET or POST) the controller naturally knows which method to invoke. Next, it invokes the domain services and selects an appropriate View to display. The View is constructed using a Razor view engine, based on selected template and provided data. In this context, the data refer to the domain entity of the logic layer. Figure 4.8 shows the binding of the model property, using the flexibility of a Razor, to a responsive

GridView in order to display credit sales transactions in a SalesLog. The model property is validated using Data Annotation. Data Annotations are attributes that provide validation for the server side as well as on the client side (Galloway *et al*., 2014). The properties that require validation are aligned to attributes with particular validation rules as illustrated in Figure 4.9 The ASP.NET frameworks generates the corresponding validation rules on the client side view.

```
<ul id="myTabs" class="nav nav-tabs" role="tablist"> <li role="presentation" class=""><a href="#home" id="home-tab" role="tab
<div class="panel-info widget-shadow">
    <div align="left">
        <button type="button" class="btn btn-primary btn-lg" data-toggle="modal" data-target="#exampleModal" data-whatever="@
    <form class="input">
        <input placeholder="Search Sale..." type="search" id="input-31" />
        <label class="input__label" for="input-31">
            <svg class="graphic" width="100%" height="100%" viewBox="0 0 404 77" preserveAspectRatio="none">
                <path d="m0,0l404,0l0,77l-404,0l0,-77z" />
            </svg>
        </label>
    </form>

    <div class="table-responsive bs-example widget-shadow">
        <table class="table">
            <tr>
                <th>
                    @Html.DisplayNameFor(model => model.customers.refCustID)
                </th>
                <th>
                    @Html.DisplayNameFor(model => model.category)
                </th>
                <th>
                    @Html.DisplayNameFor(model => model.itemName)
                </th>
                <th>
                    @Html.DisplayNameFor(model => model.quantity)
                </th>
                <th>
                    @Html.DisplayNameFor(model => model.total)
                </th>
                <th>
                    @Html.DisplayNameFor(model => model.dueDate)
                </th>
                <th></th>
            </tr>

            @foreach (var item in Model)
            {
```

Figure 4.8: Code snippet of an Index View (Saleslog-Credit Sale)

ASP.NET is a server-side technology which is a subset of .NET Framework (MacDonald 2010) which was utilized in the implementation of the system. ASP.NET supports most features of .NET framework and includes interesting services such as data storage and secure authentication. Among the .NET languages that exist, such as Visual Basic, C# and C++; C# was selected as the programming language for the system server side. The other .NET features that were involved in the implementation includes the Entity Framework (EF) and Language-Integrated Query (LINQ). LINQ extends powerful query capabilities to the syntax of C # and support almost any kind of data store (Magennis 2010).

Figure 4.9: Code snippet of ExpenditureLogModel

The MobiSalesX system uses Microsoft SQL Server Express, which is a relation database management system that is powerful in delivering rich and reliable data store for lightweight web-based applications. Microsoft SQL Server Express works across a variety of devices and data sources, from desktops, mobile phones, and tablets (Mistry and Misner, 2012). In addition, it also works well with private and public clouds. It was effortless to integrate this technology into the system because it is supported by the IDE used. The system is hosted in the cloud environment, specifically Microsoft's Azure cloud (Microsoft Azure, 2015). Cloud hosting is an innovative method, based on cloud computing, where an application is hosted on virtual multiple interconnected servers that encompass a cloud. This concept is associated with mobile cloud computing where data processing and storage are moved from the mobile device to powerful and centralized computing platforms located outside the device (Dinh *et al*., 2013; Fernando *et al*., 2013). Mobile cloud computing addresses the problem of limited-resource devices (Fernando *et al*., 2013) that can be potentially used by VSEs to access MobiSalesX system. Furthermore, it adds the advantage of improving data storage capacity and processing power, extending battery lifetime, improving reliability and scalability (Dinh *et al*., 2013).

4.6. **Demonstration of MobiSalesX Prototype**

This section presents the demonstration of MobiSalesX system prototype through a series of screenshots. One of many distinct features of MobiSalesX is that it is based on web technology which is a powerful alternative to native application (Kovachev *et al*., 2011). The MobiSalesX system implementation is inexpensive due to the mere fact that it utilizes common knowledge of web technologies and it imposes no resource demands on the end user device since it uses the web browser and takes advantage of the cloud for storage capacity and processing power. Peffers *et al.* (2008) asserts that the demonstration of a system should clearly show how the system itself addresses some instances of the problem. Here the focus is not only to illustrate how the system solves the problem of VSEs but also to demonstrate the distinct functions that make the system suitable for the business of VSEs.

4.6.1. **Main Menu**

The system requires that the VSE registers in order to access the services of MobiSalesX. Every time the VSE Retailer attempts to access the system, the system prompts for username and password inputs. This authentication mechanism was embedded in the system for sake of ensuring that only rightful users can gain access to the system as show in Figure 4.10.

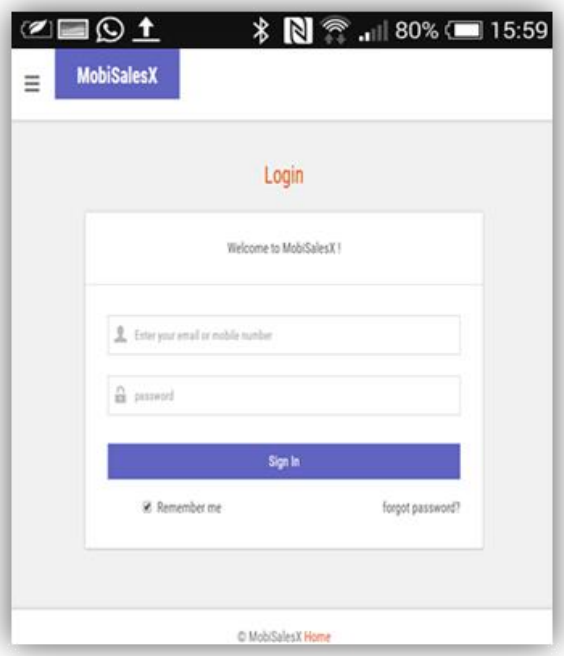

Figure 4.10: Login/Sing-Up screen

It was decided that, because most VSEs do not have email accounts, the system should cater for either a mobile number or email address for username purpose. This idea

accommodated many VSEs to utilize the system because every mobile user is likely to own a mobile number. The VSEs choose their own passwords, based on the rules that guided the password content. The rules that were employed allowed VSEs to have passwords that are short enough to allow memorization. Once VSE retailer is authenticated, the system loads the menu interface where the VSE could navigate through any service function of the system as shown in Figure 4.11

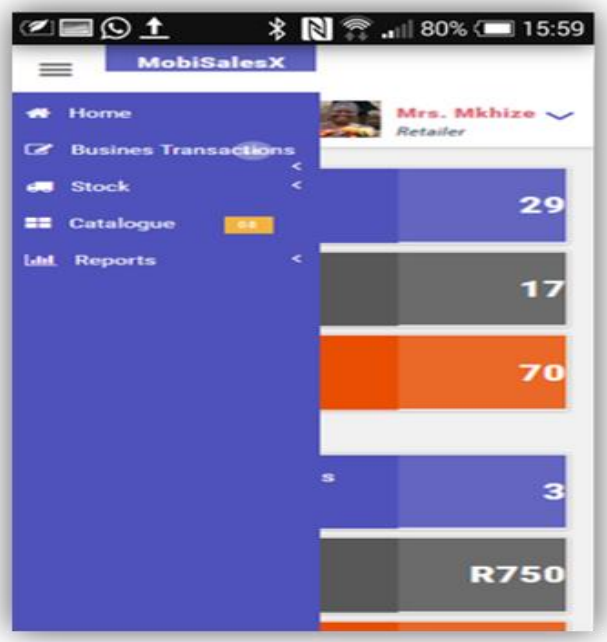

Figure 4.11: Main Menu screen

These functions of MobiSalesX are positioned on the sidebar menu to facilitate easy navigation, without delays and deviations. The functions of the system can be expended to access precise services. The system uses icons, images, symbols, and labels that are comprehensive enough for the VSE; easy to understand and consistent. For instance, a pen and paper icon is used in the system to represent the function of recording business transactions. Using representative icons is important for novice users (Gatsou *et al.*, 2012) and it influences the usability of the system. The VSE retailer can manage his/her profile and customize some of the MobiSalesX system settings as shown in Figure 4.12

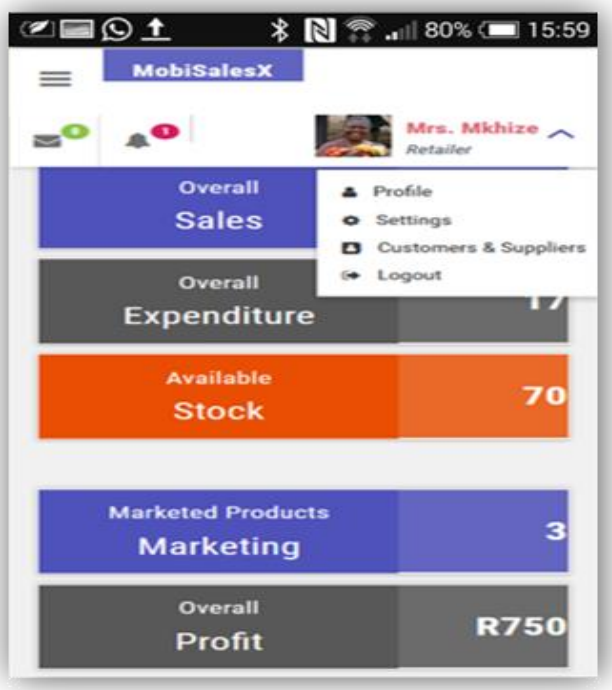

Figure 4.12: Profile and other settings screen

4.6.2. **Sales**

The sales transactions of VSEs are captured in a Saleslog unit. The Saleslog unit is partitioned into two compartments: cash sales and credit sales. The Saleslog uses a grid-view style to present the business transactions of VSEs and includes a filtering feature that enables efficient search for specific sale transaction. Figure 4.13 below demonstrates the cash sales compartment of the unit. The VSE uses the built-in pager to navigate through all cash sales transactions that have been captured into the system.

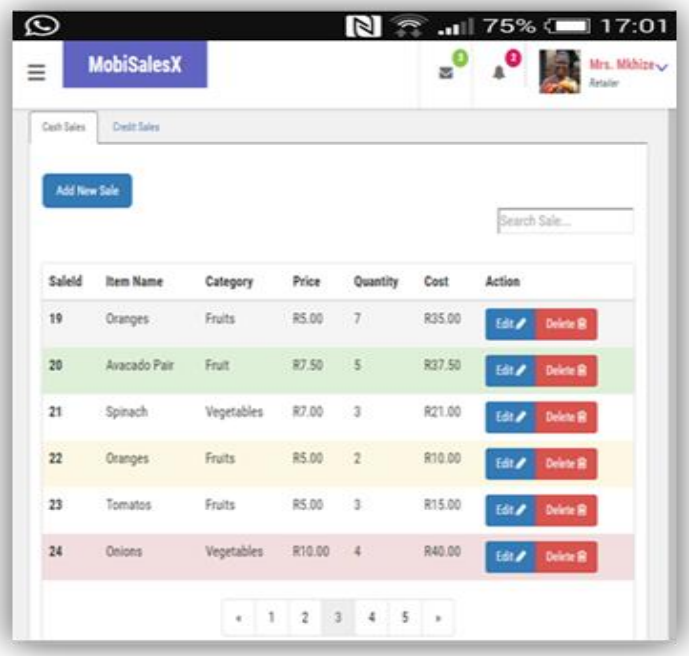

Figure 4.13: SalesLog Unit - Cash Sales screen

The presentation of credit sales compartment in the Saleslog unit is similar to that of cash sales. Figure 4.14 shows how credit sales transactions are displayed in the Saleslog unit. VSEs recognize trade credit an as efficient tool for boosting their sales and increasing profitability (Tang 2014). Every credit transaction is associated with a particular customer; who's details are already on the system.

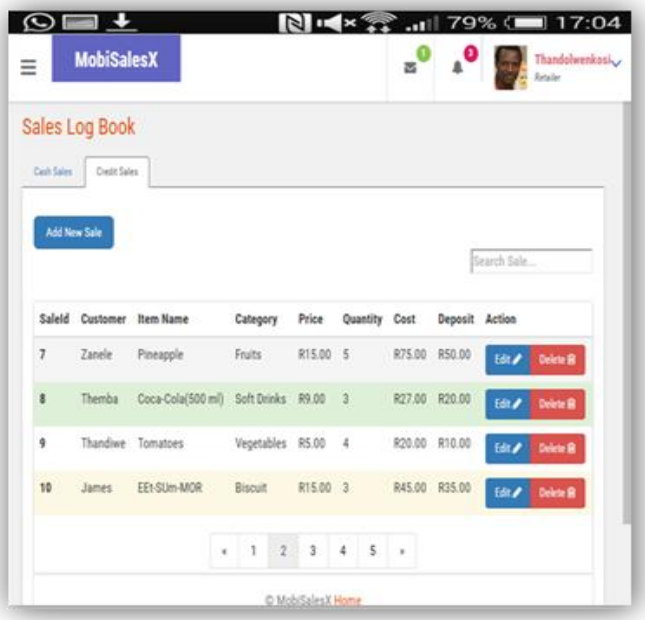

Figure 4.14: SalesLog Unit - Credit Sales screen

To capture a new credit sale transaction, the VSE clicks on the button "Add New Sale" on the mobile device screen which brings the dialog popup window for new credit sale entry as shown in Figure 4.15. This dialog popup window is displayed on the current user screen and this practice reduces the effort of navigating through different screens of the system and increases user experience. This procedure of capturing business transactions in MobiSalesX is consistent in all parts of the system. The intention of doing so was to promote ease of use in the system. The information which is populated for selection choice is based on the VSE stock which is managed and controlled by the system.

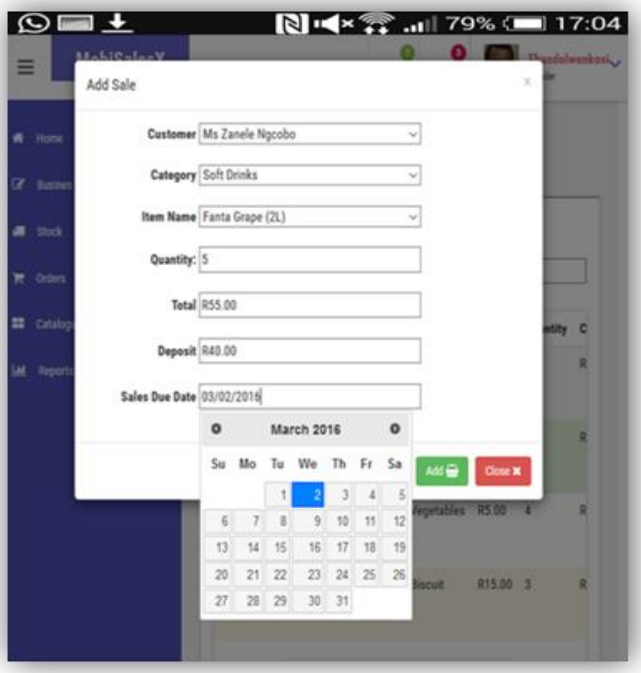

Figure 4.15: Capture Credit Sale Transaction screen

4.6.3. **Debtors**

After the VSE has committed or recorded the transaction, the system automatically sends an SMS to the customer informing him/her about the due date of settling the outstanding credit balance and the Debtors unit, which is part of the system, gets updated instantly. Figure 4.16 demonstrates the Debtors unit of MobiSalesX. The system uses colored labels to distinguish debts: red for overdue debts (not paid), orange for unsettled (not paid) and green for settled debts (paid). This mechanism fulfils the information drive of unison in frugal IS (Watson *et al.*, 2013).

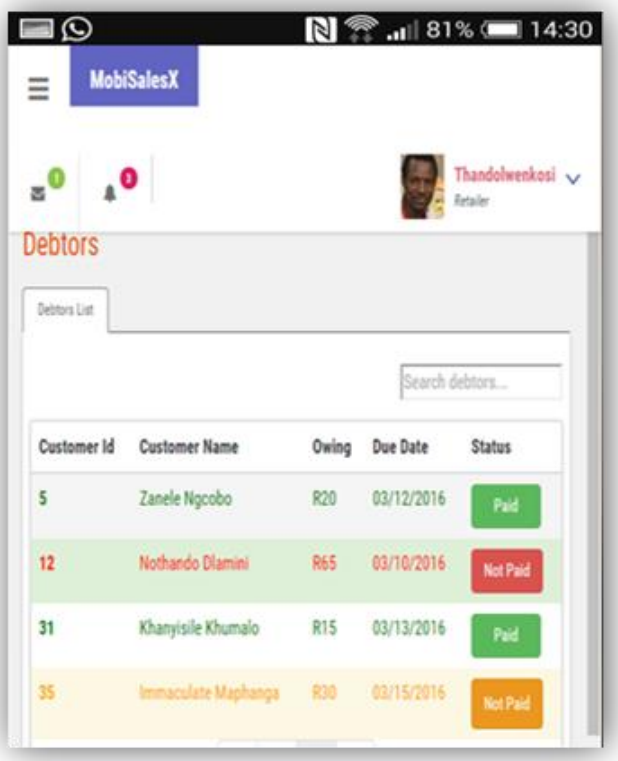

Figure 4.16: Debtors screen

4.6.4. **Stock**

The Stock unit in MobiSalesX system substitutes the eyeball system that most VSEs use and facilitates smooth management of VSE stock. The Stock unit provides assistance to VSEs in terms of monitoring their stock movement, discounting stock items, and updating stock with low quantity. In addition, it also enables VSEs to set a specific threshold for each item on stock and monitors the movement of that item, such that when the item reaches its threshold a notification is sent to the VSE as shown in Figure 4.17 The Stock unit also performs item recommendation for mobile customers, and this is done based on image content and user preference information (Olugbara *et al*., 2010).

Figure 4.17: Stock notification screen

4.6.5. **Marketing**

Takhar *et al*., (2013) state that it is critical for owners of small businesses to explore proactive and innovative marketing avenues. The MobiSalesX system uses the SMS technology, which is compatible with all mobile phones, to market the products of VSEs as shown in Figure 4.18. Mobile SMS marketing is one of the cost effective and reliable marketing strategy, which allows real-time engagement with current customers and holds a great potential of attracting new ones. The MobiSalesX system supports the use of African indigenous

languages which reduces the issue of language barrier as far as marketing is concerned. This, subsequently, could result in an increase in VSE sales which in turn will positively affect their profit.

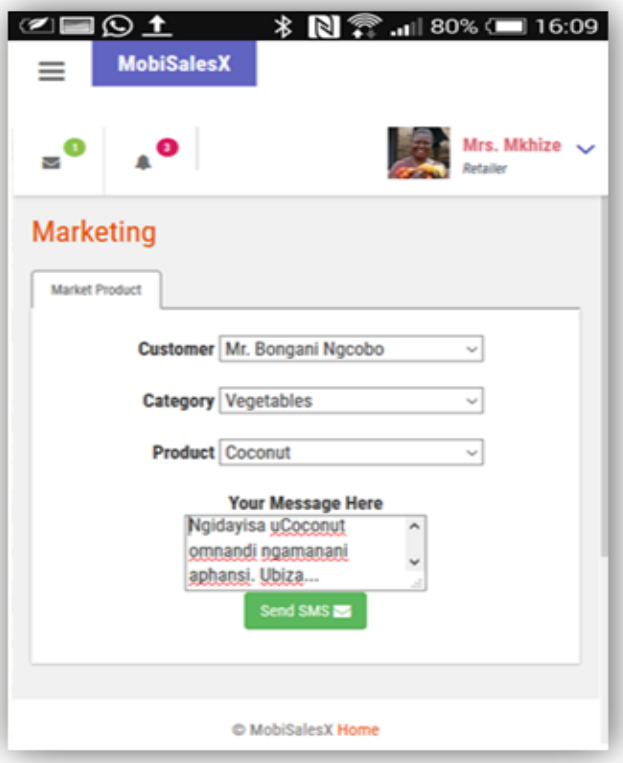

Figure 4.18: Marketing screen

4.6.6. **Expenditure**

The ExpenditureLog unit in MobiSalesX system captures all the business transactions that represent the money that was spent by the VSEs. This unit deals with business transactions such as stock purchase, rent, water and electricity, and salary and wages which may be incurred by the VSE. To ensure the authenticity of every transaction and to control fraudulent practices amongst VSEs, the ExpenditureLog demands a digital photo copy of a receipt upon adding a new transaction entry on the system. Parry (2009) writes that "photos communicate more convincingly than do words…" Figure 4.19 shows the ExpenditureLog unit of MobiSalesX system.

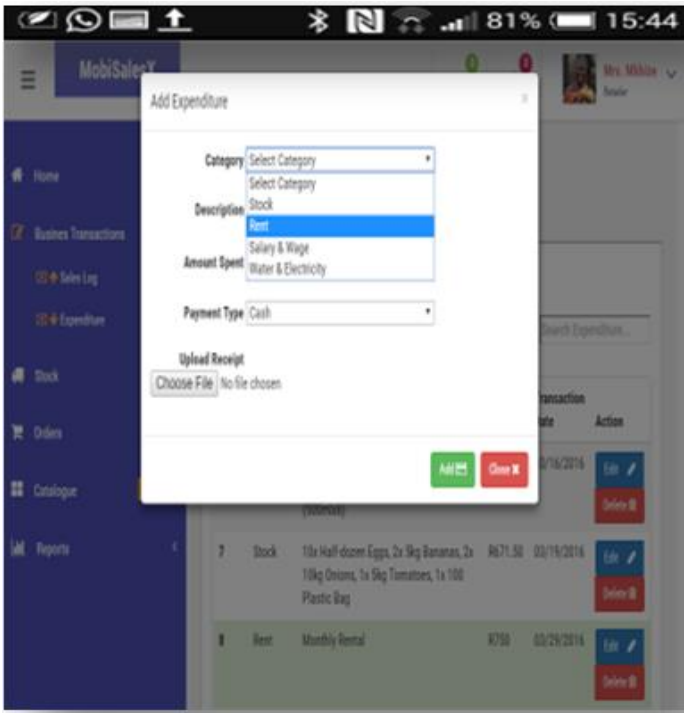

Figure 4.19: ExpenditureLog screen

4.6.7. **Reports**

The MobiSalesX systems support financial reporting as seen in Figure 4.20. According to Rathnasiri (2014), financial reporting is crucial for the wellbeing of small businesses, including VSEs, and to strengthen their economic and social contribution.

Figure 4.20: Reports screen

4.7. **Conclusion**

This chapter discusses the implementation process of *MobiSalesX* system which supports VSE business transactions and provides essential enterprise management services with the aim of improving VSEs business financial management and increases their business performance. This chapter describes in detail how the user requirements (URs) of the system were formulated, and what methods were employed to elicit these URs. The URs of the system were analyzed to address the functions that were essential to the design of MobiSalesX system. The functions of the system were presented using UML/OCL to better comprehend the design aspects of the system in detail. System modeling enabled conceptual representation of MobiSalesX which guided the actual implementation of the artefact. The UI design of MobiSalesX concentrated on the presentation of the system, the aspect of usability, which needed to be filled in order to accommodate different mobile device types with different screen size. This was critical for the system that targeted any mobile device that VSEs already had. The design of the system proven that it has fastidiously considered the system models that were ultimately produced and the constraints that were supposed to be met; and these models were ultimately used in the implementation of the system. This chapter also covered the implementation of MobiSalesX system and demonstrated how the system works. The next chapter discusses the evaluation process of MobiSalesX system. In particular, it describes how the observational and experimental evaluations were applied in the system.

CHAPTER 5: EVALUATION OF MOBISALESX ARTEFACT

This chapter reports on the evaluation of the MobiSalesX artefact and its design. MobiSalesX is a frugal IS that is primarily developed to support VSE business transactions. The *ex-ante* perspective and *ex-post* perspective (Pries-Heje *et al*., 2008) were considered for the purpose of evaluation. The system dimensions which are assessed, together with their evaluation criteria, were obtained from the study of Prat *et al.* (2014). The study of Prat *et al.* (2014) was of high significance in this chapter because it informs researchers on what should be evaluated in IS artefacts, which are a result of DSR, and how the evaluation should be performed. This chapter is structured as follows. Section 5.1 presents the evaluation approach that was followed to evaluate the artefact and its design. Section 5.2 discusses the system dimensions and evaluation criteria that were deemed suitable for achieving the objectives of this dissertation. Section 5.3 describes the methods that were used to address the system dimensions and the evaluation criteria that were considered meaningful for the purpose of this study. Section 5.4 discusses the evaluation results. Section 5.5 provides a succinct conclusion of the overall evaluation.

5.1. Evaluation Approach

The evaluation of artefacts is a pivotal part of DSR (Ostrowski and Helfer 2012; Peffers *et al.*, 2012; Cleven *et al*., 2009; Hevner *et al*., 2004). According to Hevner *et al*. (2004) evaluation of an artefact provides a better understanding of a problem and also creates a platform for identifying strengths and weaknesses of the artefact. Identifying weaknesses in an artefact through evaluation often helps in studying possible improvements that could be made in order to strengthen the overall quality of that artefact. The evaluation of DSR artefacts in IS can be carried out in different approaches (Peffers *et al.*, 2008). However, it is argued that the most suitable evaluation approach would depend on the nature of the artefact itself and the problem being solved. The artefact of this dissertation is classified as an instantiation - a system (Peffers *et al.*, 2012; Hevner *et al*., 2004). Prat *et al.* (2014) argue that IS artefacts whereby a DSR process was followed are systems.

The evaluation of artefacts in DSR is considered from these perspectives: *ex-ante* perspective and *ex-post* perspective (Prat *et al.*, 2014; Venable *et al*., 2012; Pries-Heje *et al*., 2008). The *ex-ante* perspective is the evaluation of uninstantiated artefacts, while the *ex-post* perspective is the evaluation of instantiated artefacts (Prat *et al.*, 2014). In this study, both evaluation perspectives were taken. For an *ex-ante* perspective, the design of the system was evaluated and for an *ex-post* perspective, the actual system prototype was evaluated. Figure 5.1 below diagrammatically illustrates the points where each evaluation perspective was considered.

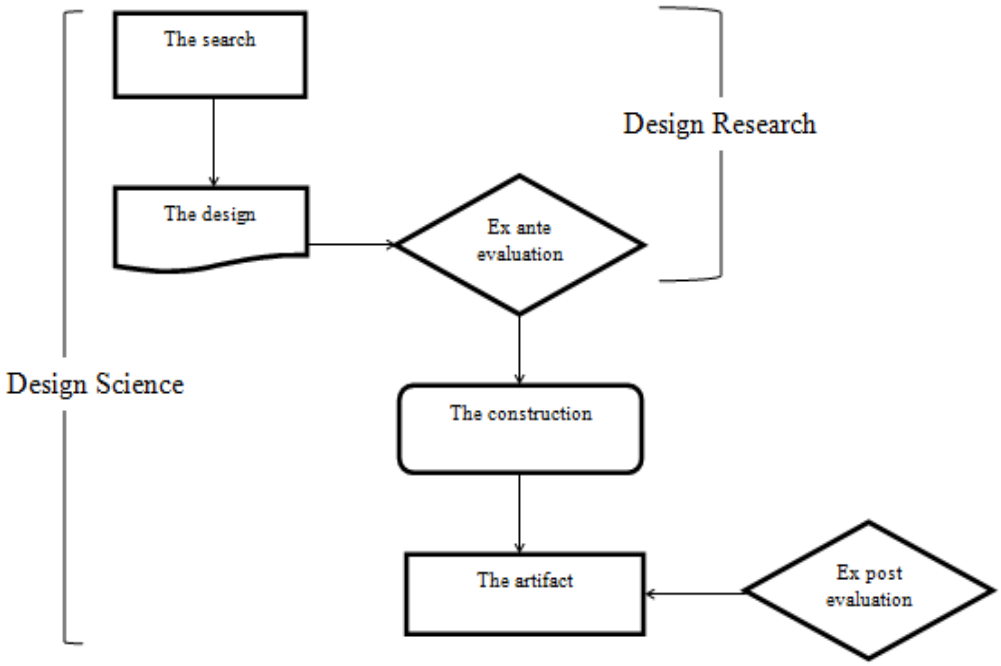

Figure 5.1: The ex-ante and Ex-post perspectives

There are two forms of evaluation processes in DSR which can be employed, namely, naturalistic and artificial. Artificial evaluation process refers to a non-realistic evaluation that involves laboratory experiments, mathematical proofs, and simulations (Venable *et al*., 2012; Pries-Heje *et al*., 2008). The naturalistic evaluation process involves engaging directly with users in a real life environment, observing them while they're using the system and asking them questions in order to get an understanding of their behaviour, feelings and emotions that are conjured up during the system evaluation (Olugbara and Ndhlovu 2014). Both evaluation processes were considered in this study. The *ex-ante* perspective followed the artificial evaluation process, and the *ex-post* perspective took on the naturalistic evaluation. The evaluation strategy which was deemed suitable, after prudently considering the objectives of this dissertation, was the criteria-based evaluation (Cronholm and Goldkuhl 2003).

5.2. System Dimensions and Evaluation Criteria

The study of Prat *et al.* (2014) focuses on how evaluation should be carried out and what is to be evaluated for IS artefacts that are a result of conforming to DSR process. In their study, Prat *et al.* (2014) constructed a hierarchy of evaluation criteria which are coupled to five system dimensions. Out of the five system dimensions, only four were of interest in the evaluation of MobiSalesX system. These system dimensions are structured, goal, activity and environment. The evaluation criteria which were used in this study were also taken from their hierarchy; however, those evaluation criteria that did not attend to the objectives of this dissertation were omitted. The literature highlights that the evaluation criteria to be used in any research study often rely upon the nature of the artefact and the targeted objectives.

The objectives of this dissertation which are centred on evaluation are: ii) to evaluate the design complexity of a mobile web-based frugal IS designed for VSEs, and iv) to evaluate the usability of the developed mobile web-based frugal IS in the environment of VSEs. The objective ii) was aligned with the structure system dimension and mapped to the "*simplicity*" criterion. The objective iv) was tied with the other three dimensions, namely, goal, environment, and activity. The evaluation criteria that were considered for this objective iv) were deduced from the definition of usability given by Baharuddin *et al*. (2013). The evaluation criteria which were identified are "*effectiveness*", "*efficiency*" and "*satisfaction*". However, in order to make these evaluation criteria relevant to this study, they had to be associated with the evaluation criteria found in the hierarchy of Prat *et al.* (2014). Effectiveness was considered as efficacy". This association can be recognized in the study of Hevner *et al*. (2004), where they use these terms interchangeably. In the hierarchy of Prat *et al.* (2014), efficacy is organized along the goal system dimension. Efficacy assesses the degree to which the artefact achieves its goal. Efficiency is the relation between the accuracy and completeness with which the users achieve certain goals and the resources expended in achieving them (Harrison *et al*., 2013; Frøkjær *et al*., 2002). Prat *et al.* (2014) organize this criterion along an activity system dimension. Satisfaction refers to the user comfort and positive attitude toward the utilization of the system (Harrison *et al*., 2013). In this study, this criterion was considered as "*consistency with people*" criterion which is realized in the hierarchy of Prat *et al.* (2014). This criterion is organized along environment system dimension.

Table 5.1 below shows the four system dimensions along with evaluation criteria that were considered for addressing the objectives of this dissertation which are evaluation-centred.

Table 4.3: Evaluated system dimensions and evaluation criteria

System Dimension	Evaluation Criteria
Goal	Efficacy
Structure	Simplicity
Environment	Consistency with people
Activity	Efficiency

5.3. Evaluation methods

5.3.1. Evaluating Design Complexity

The decision of choosing the appropriate evaluation method is crucial. According to Peffers *et al.* (2012), the choice of the right evaluation method is highly informed by the nature of the artefact. The ADVIAN method (Linss and Fried 2010; Linss and Fried 2009) was explored for the purpose of evaluating the design complexity of the frugal IS. The ADVIAN method is usually used for analysis and numerical representation of system complexity. It is actually a state of the heart impact analysis method which improves on methods such as MICMAC through considering the indirect impact of impact factors and their impact strengths (Linss and Fried 2010; Linss and Fried 2009). Generally, impact analysis methods are used for the purpose of finding out the relationship between impact factors (sometimes called influencing factors) and to identify the essential impact factors for optimizing the system (Linss and Fried 2009). Most of these methods often use a system metaphor to make the system elements and their interdependencies understandable. Similarly, in IS, system metaphors are used to express the nature of the design of an IS and how the system elements are related (Gazendam 1999). An architecture is a good example of a system metaphor which is very useful in explaining the design of IS (Wake and Wake 2001; Gazendam 1999).

In this study, the architecture of MobiSalesX system was represented through a UML class diagram, showing the system elements and their interdependencies. These system elements, which are object classes, were considered as impact factors as far as the ADVIAN method is concerned. This was fitting because, the definition of the word "*factor*", in various

knowledge sources, highlights that it is something that contributes towards producing a particular result. For example, in the Dictionary.com the word factor is defined as "*one of the elements contributing to a particular result or situation*[1]". Therefore, each object class in MobiSalesX system architecture can be regarded as a factor since it contributes toward the creation of a system. In object-oriented analysis and design, object classes have impacts on each other and this concept is known as method invocation or message passing (Pedroni and Meyer 2010; Briand *et al*., 1999). This explains the rationale of considering object classes as impact factors.

Generally, the complexity of system design, for object-oriented systems, is usually identified and assessed through coupling and cohesion (Patidar *et al*., 2013; Saxena and Kumar 2012). Coupling is a measure of the strength of relationship established by a connection of one object class to another in a system (Mandal and Saini, 2015; Eder *et al*., 1994). Cohesion measures the degree of association of the elements defined within an object class (Saxena and Kumar 2012). These two concepts are correlated, in that if cohesion is low, then the coupling is high. The literature reveals that for an object-oriented system to be considered well-designed, it has to have low coupling and high cohesion (Mandal and Saini 2015; Saxena and Kumar 2012). The concept of coupling was used in conjunction with the ADVIAN method to evaluate the design complexity of MobiSalesX. It is worth taking note that, although coupling and cohesion are usually used when studying the design complexity of object-oriented systems, in this study only coupling was considered. This was done because, apart from coupling being the most important factor to be considered during design (Bidve and Sarasu 2016); it is more useful and convenient for determining the complexity of system design (Patidar *et al*., 2013).

In this research study, coupling was used for assigning the strength of relationships that were realized in the design of MobiSalesX. There are three different dimensions of coupling that were studied, namely, interaction coupling, component coupling, and inheritance coupling. Interaction coupling occurs when methods of different classes invoke each other and/or are sharing data (Eder *et al*., 1994). Inheritance coupling exists when one object class is a direct or indirect object subclass of the other (ALGhamdi *et al*., 2002). Component coupling is defined by the use of an object class as a domain of some instance variable of another object class (Eder *et al*., 1994). This is what Virdi and Singh (2012) refer to when stating that component coupling is caused by abstract data type. The strength of

[1] Definition of factor available at http://www.dictionary.com/browse/factor

coupling can be described as how much, how complex and how explicit is the information that is shared between coupled methods or object classes (Eder *et al*., 1994).

5.3.2. **Evaluating System Usability**

According to Nayebi *et al*. (2014), there are three usability evaluation methods which are currently used in studies that deal with mobile-based usability: laboratory, field and hands-on. However, among these methods, laboratory and field are the most discussed methods when it comes to evaluating mobile systems (Ahmad *et al*., 2014; van Elzakker *et al*., 2013; Kaikkonen *et al*., 2005). Although there is still an argument over which method is more appropriate in the literature (Sun and May 2013), it appears that each of these usability evaluation methods has its own advantages and disadvantages (Nayebi *et al*., 2014; van Elzakker *et al*., 2013). It is good to remember that the artefact which was developed in this study is a mobile-based system. Isomursu *et al*. (2005) suggest that mobile based systems should be evaluated in mobile context. This proposition seems appropriate because laboratory evaluation, especially when dealing with mobile systems, does not only lacks realism, but it also fails the notion of mobility (Olugbara and Ndhlovu 2014; Trivedi and Khanum 2012; Kjeldskov and Stage 2004). Hence, a field study method (Hevner *et al*., 2004) was deemed suitable for evaluating the usability of MobiSalesX prototype system in a real-world working environment of VSEs.

5.4. Evaluation Results and Discussions

5.4.1. **Design Complexity of MobiSalesX system**

This section presents the evaluation results and discussions of the objective that is aimed at assessing the design complexity of a mobile web-based frugal IS designed for VSEs. The ADVIAN method was used with a flavour of coupling to assess the design of MobiSalesX.

The ADVIAN method uses the common classification which varies between 0 (no impact) and 3 (strong impact) (Linss and Fried, 2010) for assigning impact factor strength. The same strength classification was used for coupling in this dissertation: 0 = no coupling, 1 = weak coupling, 2 = moderate coupling and 3 = strong coupling. The cross-impact matrix in Table 5.1 depicts the number of object classes in the architectural design of MobiSalesX system squared and the coupling strength of every object class on other object classes in the system. The object classes are as follows: C1 is User, C2 is Customer, C3 is Retailer, C4 is

Supplier, C5 is Sales, C6 is Credit Sales, C7 is Cash Sales, C8 is Stock, C9 Expenditure, and C10 is Catalogue.

Table 5.1: Impact matrix for system elements in MobiSalesX architectural design

Classes	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10
c1	1	1	1	1	0	0	0	0	0	0
c2	0	1	0	0	0	3	0	0	0	0
c3	0	1	1	1	1	0	0	0	1	0
c4	0	0	1	1	0	0	0	0	2	0
c5	0	0	1	0	0	1	1	1	0	0
c6	0	2	1	0	0	0	0	1	0	0
c7	0	0	1	0	0	0	0	1	0	0
c8	0	0	0	0	2	0	0	1	0	2
c9	0	0	1	0	0	0	0	0	0	0
c10	0	0	0	0	0	0	0	0	0	0

The object classes that result in MobiSalesX were classified according to different criteria which are based on ADVIAN classification (Linss and Fried 2010) as shown in Table 5.2. The integration, stability and criticality classification described the condition state of the system design. The precarious, driving and driven classification showed the perspective for intervening actives in the design of the system. This classification was of paramount importance, essentially because change is inevitable when developing and/or maintaining IS (Lim and Finkelstein 2011). Hence the existence of software change impact analysis (Lehnert 2011). The classification of Linss and Fried (2010) converts the active and the passive sum of all impact factors into relative values, in order to make the classification applicable to any system. Thus, all relative active and passive sums of object classes in the system design have values ≥ 0 to ≤ 100. The calculations and the corresponding graphs were produced using Microsoft Excel Add-In.

Table 5.2: ADVIAN classification according to different criteria

Class No.	INDAS	INDPS	RINAS	RINPS	Integration	Criticality	Stability	Precarious	Driving	Driven
1	41.35	1.17	74.80	2.11	38.45	12.56	95.89	30.66	80.87	13.58
2	46.08	55.28	83.36	100.00	91.68	91.30	9.08	87.24	26.93	29.49
3	43.82	51.99	79.28	94.06	86.67	86.35	13.96	82.74	32.89	35.83
4	25.92	20.23	46.90	36.59	41.74	41.43	58.89	44.08	52.41	46.30
5	36.04	31.10	65.19	56.26	60.73	60.56	39.60	62.84	50.70	47.10
6	43.16	51.16	78.08	92.55	85.32	85.01	15.30	81.47	34.21	37.25
7	19.09	8.47	34.53	15.32	24.93	23.00	78.77	28.18	51.57	34.35
8	28.91	33.70	52.31	60.96	56.64	56.47	43.70	54.35	47.72	51.51
9	11.40	24.85	20.62	44.95	32.79	30.45	71.73	25.06	37.87	55.92
10	0.00	17.83	0.00	32.26	16.13	0.00	100.00	0.00	0.00	56.80

System stability	52.69156912

Figure 5.2 shows the contour lines for the integration in the design of MobiSalesX system. C2 has the highest integration because it has the highest active sum and C10 has the lowest integration because it has the lowest active sum. Linss and Fried (2010) states that the higher the active sum and the passive sum, the more relationships exist between the considered impact factor and the other impact factors in the system. This means that C2 has the strongest influence toward the complexity of the system design. However, some relationships that exist between this class and other classes in the system design are essential. For instance, the inheritance relationship that exists between C2 and C1 is crucial in object-oriented design because it promotes the overall quality of the system and supports reusability and maintainability (Eder *et al*., 1994). The other classes that also influence the system complexity in MobiSalesX design are C3 and C6.

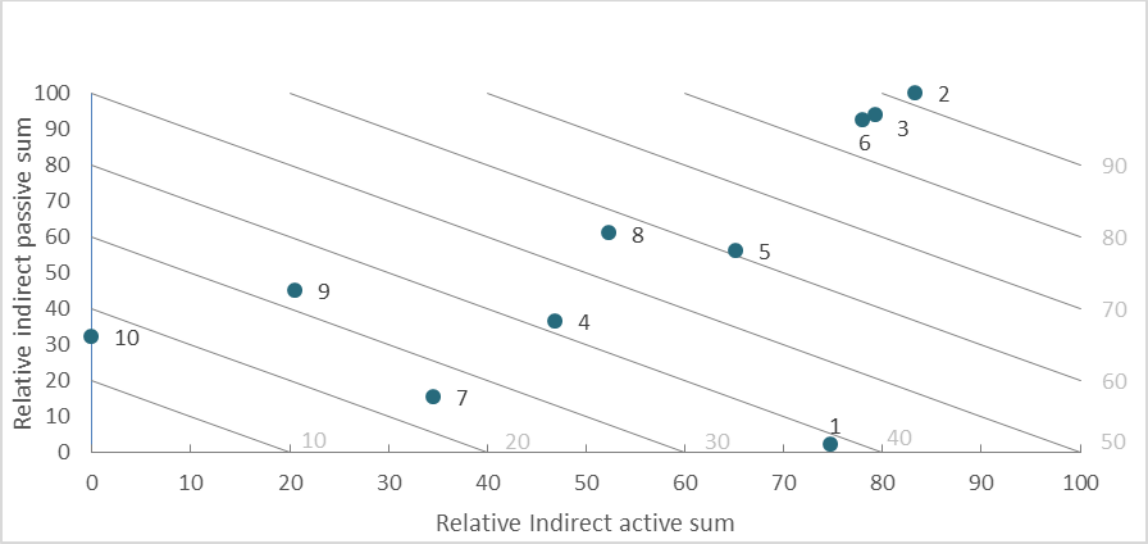

Figure 5.2: The classification of Integration criterion

Figure 5.3 presents the contour lines for the contribution of system classes toward the stability of the system. The system is considered very stable if the impact factors are distributed very closely to the axis of the active sum and the axis of the passive sum (Godet 2000). The system stability of MobiSalesX prototype was calculated using the arithmetic mean value for the stability values of all classes that were considered in the system design (Linss and Fried 2010). The following classes C1, C7, C9 and C10 were found to have a higher contribution to the stability of the system while C5 and C8 caused the most instability because they have relatively high active and passive sums at the same time. Alshayeb *et al.* (2014) assert that stable classes often reduce system maintenance cost and effort. This means that the more stable are classes in the system, the less complex the system is in essence.

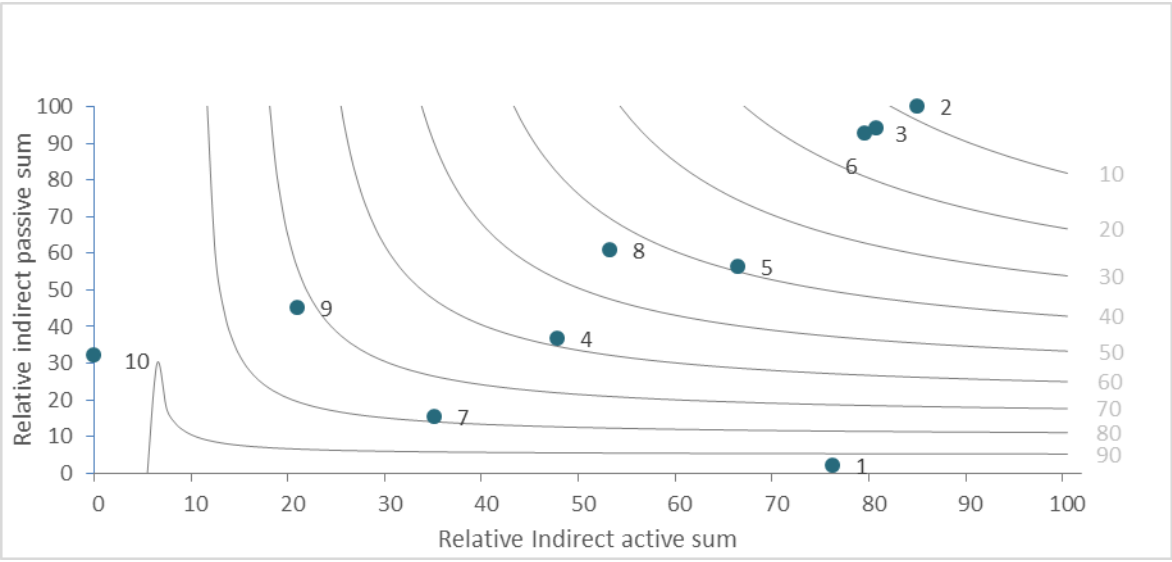

Figure 5.3: The classification of stability criterion

Figure 5.4 shows the contour lines for MobiSalesX prototype criticality. These contour lines are similar to those of system stability, but with reverse dependence on the relative active and passive sum. The higher the contribution of a class to the system stability is, the lower its number of the criticality value. The classes with high criticality have both a high active sum and a high passive sum, such classes strongly influence the system but on the other hand, they are also strongly influenced by the system (Linss and Fried 2010). C5 and C8 were found to have the highest value for criticality. Linss and Fried (2010) advise that these classes are not suitable for systematic extrinsic changes. This is because changes in these classes may affect the entire system design.

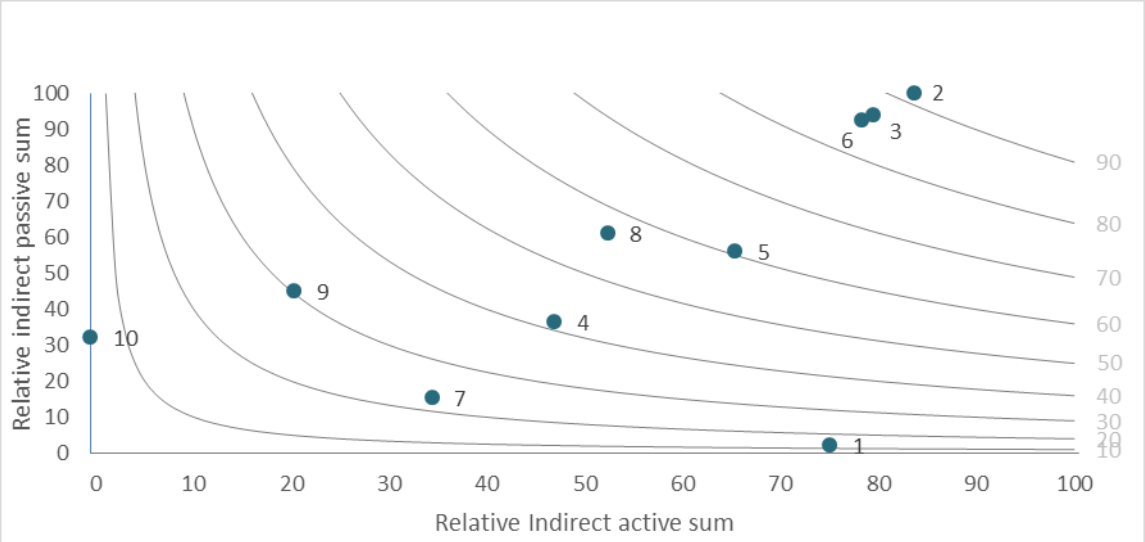

Figure 5.4: Classification of criticality criterion

Figure 5.5 presents the contour lines for the determination of the most precarious classes in the system design. The most precarious classes in the system were C2, C3, C6 and C5. Linss and Fried (2010) suggest that these classes should not be used for intervening activities. The reason for this being that, if major changes are to be made in these classes they could interfere with other intrinsic parts of the system. Hence, there's a great effort needed for maintaining these classes, which is associated with high cost because they are highly interrelated with other classes of the system. The lowest precarious ranking was found for C10, C9, C7 and C1. These classes influence modifiability, understandability and maintainability of MobiSalesX prototype system.

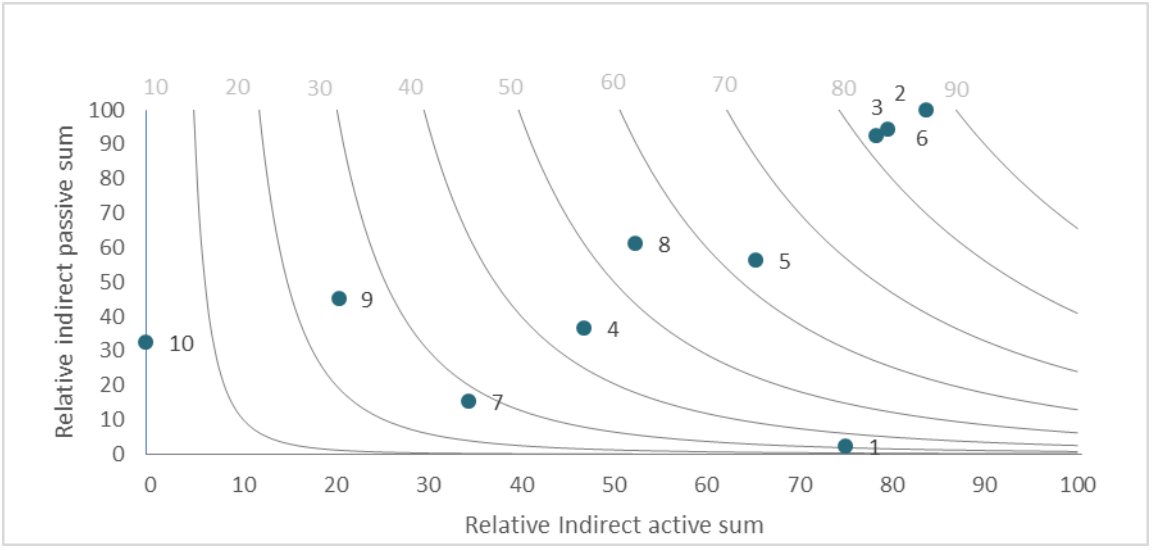

Figure 5.5: Determination of precarious classes

Figure 5.6 shows the contour lines for classes which were ranked driving. The driving classes are suitable for extrinsic actions to improve the performance of the entire system (Linss and Fried 2010). C1 would be a good starting point for intervening activities in MobiSalesX system design because it is t less rigid, less fragile and easy to reuse. What really makes this class suitable for intervening actions is that it holds a strong inherent relationship which supports reusability through sub-classing

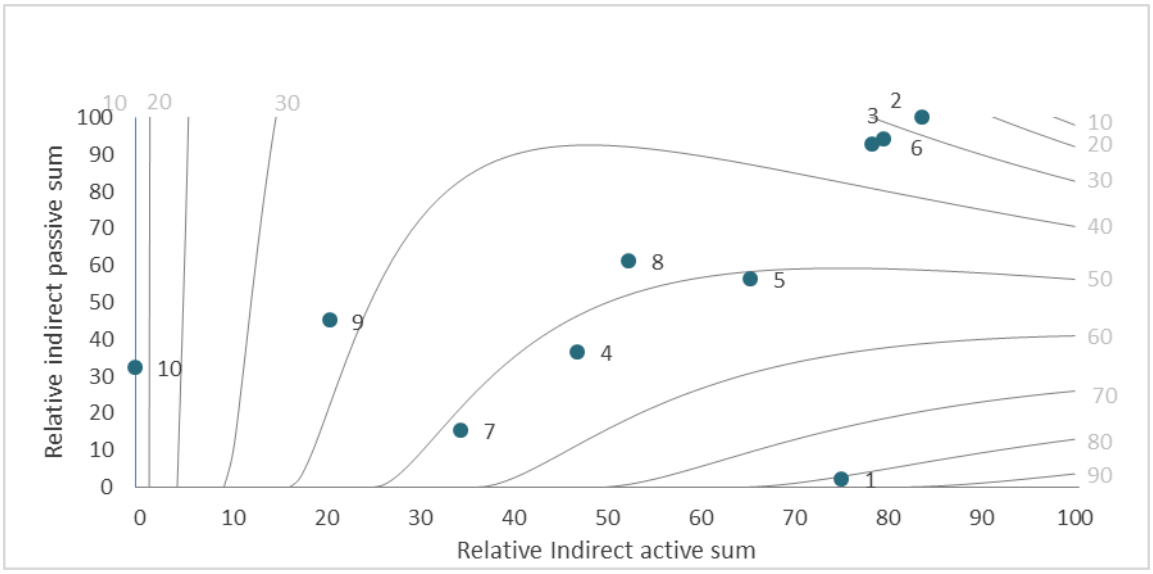

Figure 5.6: Determination of driving classes

Figure 5.7 shows the contour lines for the ranking of the driven classes. C8, C9 and C10 were found to be the driven classes in MobiSalesX system. But they were not strongly driven classes because their values were not consistent with the “reactive” classification in the system grid described in the study of Linss and Fried (2010). In this evaluation, this means that these classes can accommodate intervening activities; however, the intervention has to be minimal since these classes are influenced by other system-internal impacts.

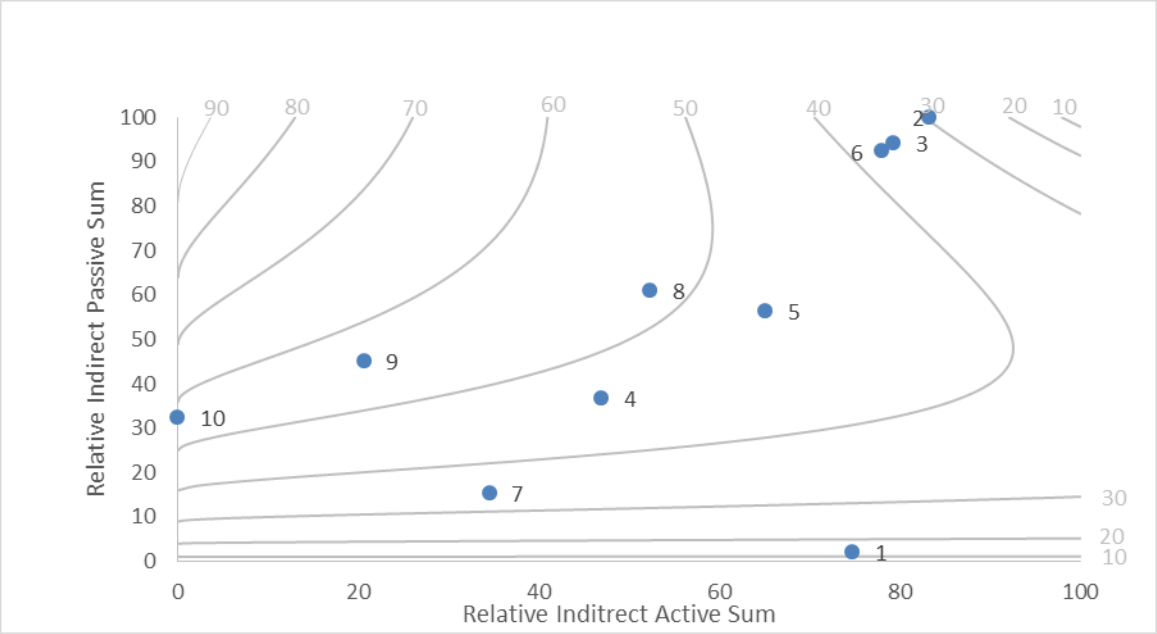

Figure 5.7: Determination of the driven classes

5.4.2. **Usability of MobiSalesX system**

The field-based evaluation used in this study is based on usability focus group with VSEs from the Kwazulu-Natal province, in South Africa. A short initial group discussion with VSE participants was held, after that the participants separated to their working space to explore the system and then later at the end of their business day, they reassembled to discuss their experiences. The focus groups were well planned and executed with appropriate rigor. Beckert *et al*. (2014) states that focus groups are very useful in the aspect of usability. According to Rosenbaum *et al*. (2002), usability focus groups can be applied at all stages of system development process and they can be used as walk-through of prototypes. The beauty of usability focus groups is that they allow moderators to collect rich qualitative information that can be highly useful to identify what worked, what did not and why (Mazza and Berre 2007). The studies of Beckert *et al*. (2014), Mazza and Berre (2007) and Kontio *et al*. (2004) are good examples where usability focus groups are employed. Usually, the setting of usability focus group discussions involves five to ten participants who are guided by the moderator who facilitates the interaction (Beckert *et al*., 2014). In the evaluation of MobiSalesX, there were five VSE participants that were involved in each focus group; hence twenty (20) VSEs participants.

It was decided that conducting evaluation in different geographic locations would help to get worthwhile views from participants with different backgrounds and skills. The evaluator played a role of a moderator during the focus group. The moderator was skilled and experienced - a computer scientist, who handled and controlled all focus groups accordingly. The discussions were structured; the moderator had a list of questions and topics to discuss with the participants, but the depth of topics and the order of questions were flexible. Depending on the level of interactions, sometimes codes switched between IsiZulu and English. The facilitator was proficient and fluent in both languages. The topics which were discussed were related to ease of use, efficiency, learnability, effectiveness, and user satisfaction. Accordingly, these topics served the evaluation criteria which were adjusted along the three system dimensions, which are environment, activity and goal.

The interactive nature of usability focus groups that were conducted with VSEs produced detailed insight because participants had a platform to voice issues and concerns that they would not have talked about in a personal interview (Beckert *et al*., 2014). In a number of occasions, the issues and concerns that VSE participants brought forward led to an interesting debate. This resulted in a better understanding as of how VSE participants used the system to achieve their goals, rather than relying on observations only. In addition, the VSE participants were asked to assess the overall usability of the system using a list of five questions. The feedbacks of participants were noted down and an audio recorder was made available to capture all the discussions. Table 8 shows the numbers of VSEs that participated and their respective locations. The majority (75%) of the VSEs were from rural regions while the others (25%) were from semi-urban regions.

Table 5.3: VSE sample for the usability field study

Number of VSE participants	Region
5	EThekwini city centre, Inanda
5	EThekwini city centre, Durban
5	UMzinyathi city centre, Nquthu
5	UMzinyathi city centre, Dundee

The VSE participants showed interest in gaining new experience and learning something new using their mobile devices. The levels of expertise of VSEs who participated were novice, intermediate and expert in their domain. All participants were met a day before the actual evaluation was conducted, for a brief training on how to use the system. Before using the system, the VSE participants were registered into MobiSalesX. Moreover, the VSE participants were offered a system user manual that essentially described the functions of the system, from a user's point of view. The participants used their own mobile devices during the evaluation and data bundles were preloaded on their devices the day before to serve the purpose of evaluation. The devices that were used by VSE participants run on different mobile platforms and hosted different web browsers. The devices that were used by the participants included Huawei Ascend Y300I, ZTE Obsidian, Nokia Lumia 520 and Vodafone Smart Tab 3G. It was suggested to the VSE participants that they use the system as business transactions happen. The system had specific features which were worth exploring and the following are some of the tasks that the participants were asked to perform: record credit sale transaction, record purchase transaction, create new user account, add a new stock item, view cash flow, view debtor's history and contact supplier.

5.4.2.1. **Ease of Use**

Most VSE participants were able to access and use MobiSalesX system with ease because the interface was well designed with simple and easy intuitive navigation. Khanyisile, a shopkeeper in UMzinyathi city centre said: "*I could easily navigate through the system, the important links are easy to find and access*". Concerning the system interface elements, the majority of participants mentioned that there is consistency in the presentation of the interface and that the use of graphical user interface (GUI) elements such as drop-downs, checkboxes and radio-buttons reduced their typing effort. This was germane because data entry with mobile computing devices is difficult, especially with devices that have small screens and keyboards (Adipat and Zhang 2005). For most VSE participants, the icons of MobiSalesX system were self-sufficient and self-explanatory. The icons were meaningful and represented the intended functions. For example, in the system, a trash look-alike symbol is used to denote deletion. However, some older VSE participants in UMzinyathi city centre expressed that certain system icons were hard to understand. One participant, particularly said: "*some icons were unclear; I struggled to understand what action they represented"*. Nonetheless, the majority of participants liked that the system provided feedbacks after performing an action. Thandolwenkosi, a grocery shop owner in EThekwini city centre

remarked that: "*Both textual and visual feedbacks were cool; for example, when I pressed the button "Save", it turned green. I also like the textual messages that came on screens, communicating the success of actions"*. Maguire (1999) states that brief feedbacks are very helpful in a system. The participants, especially those who were from semi-urban regions, responded that they found the system fairly simple and easy to use.

5.4.2.2. **Efficiency**

The MobiSalesX system interface enabled participants to finish their tasks with minimum interaction and demanded less cognitive effort from the VSEs. The number of steps it took VSE participants to accomplish most tasks with the system was kept at low levels as possible. Baguma *et al*. (2013) highlighted that a mobile system that aims to support small enterprises needs to focus on making it easier and faster to carry out business activities. Blessing, a grocery shop owner in EThekwini city centre said: "*I found the system relatively simple to use since it requires little input and it saves me time* ". On the other hand, Mandla, who's also a grocery shop owner in EThekwini city centre, argued that: "*As much as it saves time compared to recording transactions on paper, using the system during business peak hours is not easy because customers are not always ready to wait while you capture the transaction".* The MobiSalesX system prompted the users for confirmation when carrying out pivotal tasks and provided warning messages with useful information to prevent errors in the system. Cynthia, a shopkeeper in UMzinyathi city centre uttered that: "*The information provided by the system is adequate and it assisted me to complete tasks accordingly*". Most participants indicated that the search filtering feature, incorporated in most parts of the system, helped increase business efficiency. In one of the discussion sessions, one participant, Mr. Dlamini, a spaza shop owner in UMzinyathi city centre remarked that: "*I like that, instead of going through transactions jotted in my notebook, I can now quickly get access to any of my business records anywhere and anytime".* The most frequently used input data in the system, the typed history, was made easily accessible and the system provided useful suggestions on the data entry level and this effort, aggregated, promoted efficiency in MobiSalesX.

5.4.2.3. **Learnability**

The terminology that was used in MobiSalesX system played a pivotal role in learning the system. The system is written in simple English and uses well known VSE business terms. Although some participants were a bit confused with certain vocabularies, but limiting accounting and business management jargon helped to accommodate VSEs with low levels of

education. Lindokuhle, a shopkeeper in UMzinyathi city centre remarked: *"I'm not that good with English, but [the language that is used in] the system is readable and straightforward. I think most people can learn how to use the system very quickly*". Even so, an older VSE participant, Mrs. Mkhize, bickered by saying: "*I couldn't read some of the English words; I think I would learn the system quicker if it was written in isiZulu*". The messages, instructions and prompts in MobiSalesX system used a proper voice tone. Furthermore, since mobile computing devices tend to have small screens, it was imperative that the system keeps information short and concise while ensuring understandability. Phumelele, a fruit and veg shop operator said: "*I like how [error] messages are presented - there are clear and free of I. T language*".

5.4.2.4. **Effectiveness**

The functions of MobiSalesX system were designed properly and well integrated. Blessing, a grocery shop owner in EThekwini city centre expressed that: "*I'm happy that the system provides support for recording my business transactions and keeping track of items I sold on credit".* Baguma *et al*. (2013) highlighted that any mobile application or system that intends to provide business management among small enterprises, at specifically in African countries, should support credit transactions because most African retail shops practice it. Although MobiSalesX system failed at some instances to contact debtors via SMS during evaluation, but the system enabled VSEs visually see where their debtors physically live. Bonginkosi, a store owner at EThekwini city centre said jokingly: "*Because of this [map], I can now order someone to visit, door-to-door, those customers who don't like to pay me back, like Laqhasha style!*". Most VSE participants noted that the functions of tracking business financial progress worked well; however, they were not confident about it. After the moderator briefly explained how to study their financial progress; Khanyisile, a shopkeeper in UMzinyathi city centre said: "*I really didn't understand how to interpret the financial progress but it all makes sense now".* VSE participants appreciated the cash flow management function. Mandla, a grocery shop owner in EThekwini city centre, remarked that: "*I like that I can see the cash coming in and going out of my business now*". The MobiSalesX system also provided a help function, for novice users, which could be accessed with a single press on "HELP" button. This function enabled VSEs to understand the system better and use it more effectively. Most participants thought this function was useful.

5.4.2.5. **User Satisfaction**

Most participants considered the system aesthetically pleasing. Gugulethu, a shopkeeper in EThekwini city centre stated: "*I thought the system was hard at first, but I managed to learn it quickly and I find its interface effective and pleasant".* Although some participants uttered that the system gave them frustration at first, but only a few did not like the idea of MobiSalesX system. Clive, a fruit and veg shop owner at UMzinyathi city centre noted that: "*It was my first time to use my mobile phone to do business related work and it was fun and enjoyable".* Another participant subsequently added that: *"I need this system; I believe it could help me manage the business better and be more productive"*. Olubusola (2014) stated that when user satisfaction is ensured, users can get used to the system and use it regardless of wherever they are. MobiSalesX system achieves this through satisfying the frugal information drive of ubiquity. Substantially, participants who were involved in the evaluation, although the system had some errors, were generally satisfied with MobiSalesX system and its services.

In addition to the remarks that were made by VSE participants, they were asked to assess the overall usability of the system using a list of questions that were particularly designed to evaluate usability criteria discussed in Section 5.2. This was done to acquire relatively fair and unbiased results about the usability of MobiSalesX system. There were other criteria which are related to usability that were considered in this assessment such as learnability (Majrashi and Hamilton 2015). A five-point Likert scale was used to measure the response of the participants. A response score of 5 indicates "strongly agree", a response score of 4 indicates "agree", a response score of 3 indicates "somewhat agree", a response score of 2 indicates "disagree" and a response score 1 indicates "strongly disagree". Table 10 shows the percentage of VSE participants who completed the list of questions relating to system usability.

Table 5.4: Participants scoring for MobiSalesX

# Questions	Strongly agree (5)	Agree (4)	Somewhat agree (3)	Disagree (2)	Strongly disagree (1)
1. I found the system easy to use	48%	26%	17%	9%	0%
2 The system is fast to work with	28%	45%	15%	10%	2%
3. The system performed tasks properly	45%	35%	18%	2%	0%
4. Once I learned how to use the system, it was easy to use it the next time.	33%	48%	15%	4%	0%
5. I was satisfied with the system.	33%	57%	10%	0%	0%
Average % from 1-5 (usability)	37.4%	42.2%	15%	5%	0.4%

Figure 5.8 illustrates the graph corresponding to the usability of MobiSalesX system. The numbers on the X-axis in the graph corresponds with the questions listed in Table 5.4. It can be realized from the graph below that VSEs participants scored MobiSalesX system fairly high in terms of its overall usability. Most scores were categorized as "strongly agree" and "agree", with an average of 37.4% and 42.2% respectively. This indicates a positive usability scoring for the system because both categories alone make up a total of 79.6%. However, despite the convincing score of MobiSalesX, there were several issues that arouse which needed to be addressed in the prototype system.

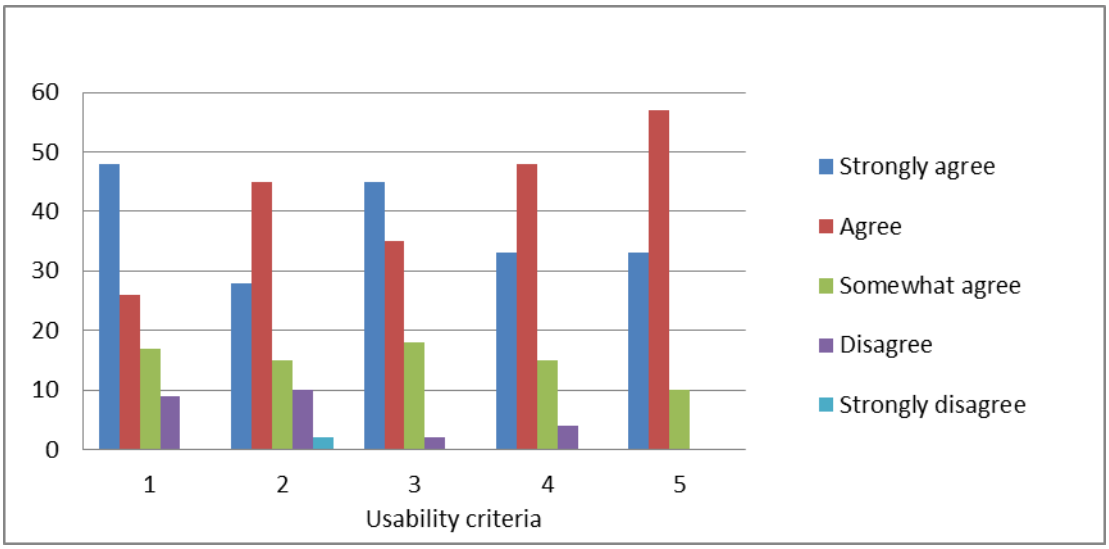

Figure 5.8: VSEs scoring of MobiSalesX system

The following list briefly highlights some of the issues and their severity that were identified in MobiSalesX prototype system. The "C" stands for critical "S" stands for serious and "M" stands for Moderate.

i) The feature of notifying VSE debtors, through SMS about their outstanding balance, did not work during evaluation (M).
ii) The system did not integrate a progress bar to reduce the anxiety of VSEs when processing or preparing some information (S).
iii) The setting feature of MobiSalesX system was limited and VSEs couldn't make changes as they desire (M).

5.5. **Conclusion**

This chapter discussed the evaluation of an artefact called MobiSalesX system and its design. The artefact that was evaluated is a mobile web-based frugal IS which supports business transactions of VSEs and provides basic essential enterprise management services. There were two objectives of this dissertation which were of concerned in this chapter: ii) to evaluate the design complexity of a mobile web-based frugal IS designed for VSEs and iv) to evaluate the usability of the developed mobile web-based frugal IS in the environment of VSEs. The design complexity of MobiSalesX system was assessed using the ADVIAN method, with help of coupling, and the result were classified according to the ADIVAN classification. The results revealed that the design of the system had relatively low complex. Gupta and Kumar (2015) states that in order to develop a system with high quality and reliability, the design has to have low complexity. The usability evaluation of MobiSalesX prototype was carried out through a field-based evaluation, precisely using usability focus groups together with questionnaires, and this yielded useful qualitative and quantitative results. However, according to Rosenbaum *et al*. (2002), the quality of the feedback obtained from usability focus groups is only good as the quality of the evaluator and questions asked. Although the feedback from VSEs concerning the artefact usability was quite positive, there were some issues which were identified that needed attention. Some participants who were involved in the evaluation process highlighted that they would prefer a local language interface in a system because of their low educational levels. However, incorporating a local language interface in any system is not a trivial task; it requires an enormous effort which is beyond the scope of this project. For example, it requires linguistic experts, who have language specialization for that targeted local language, and a great understanding of cultural differences and language complexities. Above this, these experts need to possess vast domain knowledge and experience (Gugnani *et al*., 2006). Hence, the system was worded in English -

in layman's' terms. The next chapter summarizes the current research study, presents the overall contributions made, and recommends directions for future research.

CHAPTER 6: SUMMARY, RETROSPECTION FUTURE WORK AND CONCLUSION

This chapter provides a summary discussion of the study and retrospection on research findings with respect to the development and evaluation of MobiSalesX system. In addition, the chapter covers recommendations for future research. The recommendations are suggested based on the outcomes of the experience of implementing MobiSalesX system and the evaluations of the design and usability study of the artefact. The chapter concludes by sharing the lessons learnt by the researcher throughout the research. Section 6.1 offers a summary of the overall research. Section 6.2 discusses the retrospective on research findings. Section 6.3 provides recommendations for future research. Section 6.4 provides a conclusion that briefly highlights the reflections and lessons learnt by the researcher throughout the different stages of the study.

6.1. Summary

A comprehensive review of literature that traces relevant topics as such characteristics of VSEs, challenges and issues of VSEs in developing countries, role of IS in VSEs, determinants influencing IS adoption among VSEs mobile technologies in VSEs and the rational for frugal innovation in developing countries was performed as a knowledge searching tool for this study. In particular, a review of existing mobile solutions for small enterprises, especially VSEs was undertaken to understand the strengths and weaknesses of current solutions that serve small enterprises in developing countries and to gain an insight on emerging technologies that are used to deliver these solutions. A further literature review was carried out on mobile system architectures and mobile application development approaches to discover the best frugal approach to designing and implementing the solution for VSEs. The DSRM was applied to design, implement and evaluate the artefact of this study called MobiSalesX. A novel web-based application development life cycle model, proposed by Huang *et al*. (2010) was followed to realize the MobiSalesX prototype system. This innovative model was suitable for the study because it favours the notion of frugality in a sense that it encourages the development and maintenance of quality web applications with limited resources and time. This is at the heart of frugal innovation. The MobiSalesX system was designed based on the principles and good practices of frugal IS and it satisfies the four imperative information drives, which are ubiquity, uniqueness, unison and universality

(Watson 2013; Watson *et al*., 2013). A formal specification language called OCL was used in conjunction with UML to explicitly specify the components of the system. The system was implemented using emerging technologies which include lightweight open cross-platform that is compatible with most web browsers. The prototype system that was implemented in this study is perceived as an improvement of the solution developed by Olugbara and Ndhlovu (2014). This is regarded imperative to DSR which is sometimes called "improvement research". The functions of the system which were recognized as significant improvement include expenditures function, marketing function cash flow management function, and mobile money function. These are value addition functions to the VSEs which are integral parts of a system that provides basic enterprise services and supports business transactions; integrates business processes and delivers automation consistently.

The design complexity of the MobiSalesX system was evaluated at design level and the usability study from user perspective was conducted. An *ex-ante* perspective was considered for evaluating the design complexity and an *ex-post* perspective was considered for evaluating the usability of the artefact. The method that was explored to assess the design complexity of the artefact is called ADVIAN method (Linss and Fried 2010; Linss and Fried 2009). The usability of MobiSalesX was evaluated using a field-based evaluation method based on usability focus groups (Beckert *et al*., 2014; Mazza and Berre 2007) in conjunction with questionnaires involving twenty VSE participants. The following section succinctly reflects on the research findings that were obtained through evaluation process.

6.2. **Retrospection**

There are four system dimensions that were considered for evaluation in this study, which are structure, activity, goal and environment (Prat *et al.*, 2014). These system dimensions were aligned with the respective research objectives. The structure system dimension was connected to the research objectives that aimed to evaluate the design complexity of an artefact. To ascertain the level of design complexity, it is significant to have a proper understanding of the relationships that exist within the system as a whole. The ADVIAN method was explored for the purpose of assessing the design complexity of the artefact and the concept of coupling was considered for assigning the strength of relationships that were realized. The ADVIAN analysis results which were classified according to different criteria, shown that the artefact had low complexity, high quality and reliability satisfying the requirement given by Gupta and Kumar (2015). There were relatively few relationships

which influenced the complexity of the artefact and some of those relationships were significant because they promoted reusability, maintainability and high quality of the system. Tegarden *et al.* (1995) highlighted that complexity in the system contributes to the cost of development and maintenance. For instance, the stability criterion which was realized in the artefact proved that a system to be developed could be maintained with minimal cost and effort. This was associated with the good design practice of frugal IS which emphasizes on being frugal with time, resources and scope (Watson *et al*., 2013). The evaluation of the design complexity of the artefact was considered imperative; although Watson *et al*. (2013) state that "frugal design does not imply low complexity". The results which were obtained also provided a perspective for intervening activities in the design of the artefact. This perspective was considered crucial for designing artefacts which are adaptable to future requirements. The design of the artefact was found to be less rigid, less fragile and easy to reuse.

The other three system dimensions were linked to the research objective that purposed to evaluate the usability of MobiSalesX system. Three usability evaluation methods were reviewed, specifically the ones that deal with mobile usability, which are laboratory, field-based and hands-on. A field-based study suited the investigation and the usability focus group was employed in four different geographic locations of VSEs within the KwaZulu-Natal province, in South Africa. A usability focus group is a cost effective and fast method that produces rich qualitative information, if used properly from practitioners and user experience about the object of the study (Kontio *et al*., 2004). However, there are potential chances of acquiring bias results with this method which could be caused by a number of factors such as small sample size, hidden agendas and group dynamics. Consequently, it was important to use a skilled and experienced moderator who remains objective to avoid unwanted bias. The usability focus groups were convenient for finding the strengths and weaknesses in the usability of MobiSalesX system and the value of new features. The results that were obtained provided a detailed insight because the VSE participants that were involved came with different backgrounds and had different skills, as far as ICT and education are concerned. However, because of the small size that was sampled, the results of this investigation cannot be generalized (Mazza and Berre 2007). The topics which were discussed were categorized around ease of use, efficiency, learnability, effectiveness and user satisfaction. There were miscellaneous opinions that were obtained from the VSE participants which were based on their experiences and perspectives of using MobiSalesX system. Most VSE entrepreneurs

found the system fairly simple, easy to use, easy learn and convenient. Though some expressed opinions that were otherwise to a certain extent, especially when it comes to the aspects of efficiency and learnability.

Due to poor internet connectivity in the rural regions of South Africa (Pejovic *et al*., 2012; Dalvit *et al*., 2014), the system performance was relatively slow in some instances. It is good to remember that MobiSalesX is a web-based system which highly depends on constant internet connection. One of the VSE participants highlighted that using the system during business peak hours could slow down the performance of the business especially when the system demands to be used immediately after the business transactions happens. Moreover, although accounting and business management jargons were limited in the development process of MobiSalesX system, some participants expressed that the system was not so easy to learn and suggested local language interface. However, for a country such as South Africa which has eleven official languages; developing a multilingual user interface would require great effort and resource investment.

In addition to the results which were obtained from usability focus groups, the VSE participants were asked to assess the overall usability of the system using a special list of questions. This was done to acquire relatively fair and unbiased results about the usability of MobiSalesX system. The system was scored fairly high in terms of its overall usability. Although VSEs are known for being reluctant in adopting new technologies for running their businesses (Dagdilelis *et al*., 2003), they indicated that if the production version of MobiSalesX systems was ready, they would adopt it because of the potential benefits that they realize in the system. The MobiSalesX system provides information and services that are critical to the development, growth and survival of VSEs. Watson *et al*. (2013) assert that the greatest gain of designing frugal IS will come from infopowerment. The timely, accurate and reliable business information that is maintained by the system has great potential to help VSEs make informative and sound decisions on selling and stock buying. The fact that MobiSalesX system provided basic enterprise services and delivered quality information in line with VSE business needs at low costs and using the resources that they already had, convinced many VSE entrepreneurs to opt for ICT as the basis of running their business.

6.3. **Future Work**

Since the greatest gains of frugal IS are expected to derive from infopowerment; the main recommendation for future research, could be incorporating data mining or data analytics technology into the system will could enable VSEs to gain more competitive advantages. For instance, VSEs can find valuable information for marketing by analysing their sales business transaction records through use of data mining technology. Applebaum (1951) states that "stores with credit, delivery an itemized individual sales transaction records are in possession of data from which a wide array of customer behaviour patterns can be determined". Based on the information ascertained through analysing customer behaviour patterns, VSE retailers can discover customer's interests and preferences and then make targeted recommendations via SMS or emails which could increase their profitability. Furthermore, information such as customer's characteristics, time and frequency of purchase, method of purchase and customer status can also be used to the advantage of VSEs.

As the Internet of Things (IoT) (Vermesan and Friess 2014) continues to gain further recognition as far as future technology is concerned, it is important for the domain of VSEs to explore new opportunities that are presented by this advancement. Further research investigations can be made to understand possible opportunities associated with the IoT for the domain of VSEs. Of course, the current business models adopted by VSEs will have to be revised in order for them to adapt to the new business environment that comes with IoT. A report compiled by Hogan *et al*. (2016) reveals that businesses believe that IoT, and big data, can help them to be innovate. The researcher believes that IoT and frugal IS could produce novel solutions that meet the needs of people and businesses in the developing economies.

6.4. **Conclusion**

In conclusion, this dissertation has reported on the development of a frugal IS that supports VSE business transactions. This enterprise system does not only support business transactions, but it also provides basic enterprise services, integrates business processes and information and delivers automation consistently. The system is called MobiSalesX that satisfies the four information drives of frugal IS. Sakurai *et al*. (2014) assert that the information drives of frugal IS are most likely to be fulfilled by mobile phones and their ability to connect to the internet. In this research study, mobile technologies, precisely mobile phones and internet were essentially used to meet these drives. The design of the system was

informed by a comprehensive review of the literature and guided by the principles of frugal IS. The relatively recent development technologies such as Bootstrap, HTML5 and Microsoft SQL Server Express were used to realize a lightweight solution with a slightly rich user interface. A novel life cycle model for web-based application development, proposed by Huang *et al*. (2010) was employed to anchor the entire development process. This model has proved to be frugal and flexible for developing and maintaining quality web applications with limited resources and time.

Although VSEs are known for being reluctant in adopting new technologies for running their business (Dagdilelis *et al*., 2003), but they were willing to adopt the system that was implemented in this study. However, some indicated that they needed more time to explore the system before committing to its full implementation. The system met the needs of VSEs and its potential benefits toward the survival of VSEs were recognized. The study stresses that VSEs, especially those in developing economies, need low-cost IS solutions that are tailored to their business needs, strategies and processes. Watson *et al*., (2013) state that "the great opportunity for African IS designers is to combine their knowledge of local needs and conditions with an in-depth understanding of advanced communication technology to create frugal information systems that meet the needs of citizens in the world's developing economies".

To deal with the challenges of IS adoption in VSEs, the governments and IS designers should create awareness, through improved education and training, seminars and publications about the potential benefits that enterprises could reap in adopting IS. VSEs cannot survive without any sort of IS in place to support their day-to-day business activities (Levy and Powell 2004). The exploration of ADVIAN method for assessing the design complexity of IS, using coupling strengths provided interesting and insightful findings. The field-based evaluation which employed both usability focus groups and questionnaires produced rich and insightful qualitative and quantitative findings.

Overall, embarking on this study was stimulating and it brought an indelible experience for the researcher. The interaction with the various stakeholders that contributed to the success of this research cannot be described in words. The experience of interacting with real people, addressing real problems through research was a very rewarding and fulfilling experience.

REFERENCES

Abor, J. and Quartey, P. 2010. Issues in SME development in Ghana and South Africa. *International Research Journal of Finance and Economics, 39*(6): 215-228.

Ackah, J. and Vuvor, S. 2011. The Challenges faced by Small & Medium Enterprises (SMEs) in Obtaining Credit in Ghana. *Blekinge Institute of Technology.*

Adisa, T.A., Abdulraheem, I. and Mordi, C. 2014. The Characteristics and Challenges of Small Businesses in Africa: an Exploratory Study of Nigerian Small Business Owners. *Petroleum-Gas University of Ploiesti Bulletin, Technical Series, 66*(4): 1-14.

Ademola, G. O., Samuel, O. J. and Ifedolapo, O. 2012 .The Role of Record Keeping In the Survival and Growth of Small Scale Enterprises in Ijumu Local Government Area of Kogi State. *Global Journal of Management and Business Research*, 12(23): 56-66.

Adipat, B. and Zhang, D. 2005. Interface design for mobile applications. *Proceedings of the Eleventh Americas Conference on Information Systems*. USA. 11-14 August 2005. 494.

Afolayan, A., Plant, E., White, G. R., Jones, P. and Beynon-Davies, P. 2015. Information Technology Usage in SMEs in a Developing Economy. *Strategic Change, 24*(5): 483-498.

Agwa-Ejon, J. and Mbohwa, C. 2015. Financial challenges faced by SMMES in Gauteng South Africa. International Association for Management of Technology IAMOT 2015 Conference Proceedings.

Ahmad, I. and Alam, K. 2015. Credit Flows to Pakistan's Manufacturing SME Sector. *The Lahore Journal of Economics, 20*: 261.

Aker, J.C. and Mbiti, I.M. 2010. Mobile phones and economic development in Africa. *The Journal of Economic Perspectives, 24*(3): 207-232.

Al-Mukhtar, M. and Hadi, S. 2012. Developing a Three-Tier Web Data Management Application for Higher Education Admission Environment. *Int. Arab J. e-Technol.*, *2*(4): 175-180.

Alam, S. S. and Noor, M. K. M. 2009. ICT adoption in small and medium enterprises: An empirical evidence of service sectors in Malaysia. *International Journal of Business and management*, *4*(2): 112.

Alhumaidan, F. 2012. A critical analysis and treatment of important UML diagrams enhancing modeling power. *Intelligent Information Management*, *4*(05): 231- 237.

Alshayeb, M., Eisa, Y. and Ahmed, M. 2014. Object-Oriented Class Stability Prediction: A Comparison Between Artificial Neural Network and Support Vector Machine. *Arabian Journal for Science & Engineering (Springer Science & Business Media BV)*, *39*(11): 7865–7876.

Amoako, K. O., Marfo, E. O., Gyabaah, E.N. and Gyamfi, O. (2014). Accounting records keeping practices of SMEs in Ghana: Evidence from Sunyani Municipality. *British Journal of Economics, Finance and Management Sciences*, 9 (1): 120 -132.

Antoinette, S. 2012 Mobile Application as a Tool for Improving Record Keeping and Accounting Practices of Micro Retailers. (Online). Available at: http://www.poverty-action.org/printpdf/7341. (Accessed 07 September 2015.)

Applebaum, W. 1951. Studying customer behavior in retail stores. *Journal of marketing*, *16*(2): 172-178.

Arasti, Z. 2011. An empirical study on the causes of business failure in Iranian context. *African journal of business management*, *5*(17): 7488.

Ashrafi, R. and Murtaza, M. 2008. Use and Impact of ICT on SMEs in Oman. *The Electronic Journal Information Systems Evaluation*, *11*(3): 125-138.

Asim, M. and Sahar, F. 2009. Advance Topics in Software Engineering Topic: Requirement Elicitation Techniques Case Study: Online Vehicle Trading. *Bleking Institut of Technology*.

Babu, K. D., Govindarajulu, P., Reddy, A. R. and Kumari, A. A. 2011. ANP-GP approach for selection of software architecture styles. *Int. J. Softw. Eng*, *1*(5): 91-104.

Baguma, R., Myllyluoma, M., Mwakaba, N. and Nakajubi, B. 2013. Usability and Utility Needs of Mobile Applications for Business Management among MSEs: A Case of Myshop in Uganda. In *INTERACT (2)*: 764-773.

Bajwa, I.S., Bordbar, B. and Lee, M.G. 2010.. OCL constraints generation from natural language specification. In *Enterprise Distributed Object Computing Conference (EDOC), 2010 14th IEEE International.* 25 October2010. IEEE, 204-213.

Basu, R.R., Banerjee, P. M. and Sweeny, E.G. 2013. Frugal innovation: core competencies to address global sustainability. *Journal of Management for Global Sustainability*, *1*(2): 63-82.

Baudisch, P. and Holz, C. 2010. My new PC is a mobile phone. *XRDS: Crossroads, The ACM Magazine for Students*, *16*(4): 36-41.

Beck, T. 2007, April. Financing constraints of SMEs in developing countries: Evidence, determinants and solutions. In *KDI 36th Anniversary International Conference*: 26-27.

Beckert, B., Grebing, S. and Böhl, F. 2014. A usability evaluation of interactive theorem provers using focus groups. In *International Conference on Software Engineering and Formal Methods*. 1 September 2014. Springer, 3-19

Benedict, R. G. 2012. An investigation of the accounting records maintained by black business in Qwaqwa. University of Johannesburg.

Bentabet, E., Michun, S. and Trouve, P. 1998. Training and Skills in Very Small Enterprises. *Training & Employment*.

Barnes, S.J. 2002. Unwired Business: Wireless Applications in the Firm's Value Chain. In *Sixth Pacific Asia Conference on Information Systems, Tokyo, Japan*.

Bernhaupt, R., Mihalic, K. and Obrist, M. 2008. Usability Methods for Mobile Applications. In Lumsden J (ed). Handbook Res User Interface Des Evaluation for Mobile Technology. XLIV: 745-758.

Bestvinová, V., Homokyová, M. and Horváthová, M. 2012. Financial and Tax Management in Small and Medium Sized Industrial Enterprises. *Research Papers Faculty of Materials Science and Technology Slovak University of Technology, 20*(Special Number): 16-20.

Beyer, H. and Holtzblatt, K. 1999.Contextual Design. Artville: Dion Bishop. Online). Available at: http://www4.ncsu.edu/~aianton/csc/rep/beyer.pdf. (Accessed 09 October 2014).
Bhatti, Y.A. and Ventresca, M., 2013. How can ‘frugal innovation’be conceptualized?.

Bhatti, Y.A. and Ventresca, M. 2013. How can ‘frugal innovation’be conceptualized?.

Blowfield, M. and Murray, A. 2008. *Corporate responsibility: A critical introduction*. Oxford University Press.

Borglun, E. A. M. 2008.Design for Recordkeeping: Areas of Improvement. PhD. Mid Sweden University.

Bound, K. and Thornton, I.W. 2012. *Our frugal future: Lessons from India's innovation system*. London: Nesta.

Bowen, M., Morara, M. and Mureithi, M. 2009. Management of business challenges among small and micro enterprises in Nairobi-Kenya. *KCA journal of business management*: *2*(1).

Brink, A., Cant, M. and Ligthelm, A. 2003. Problems experienced by small businesses in South Africa. In *16th Annual Conference of Small Enterprise Association of Australia and New Zealand* (28): 1-20.

Bruegge, B. and Dutoit, A.H. 2010. *Object-Oriented Software Engineering Using UML, Patterns and Java*. 3rd ed. Prentice Hall.

Butkiene, R. and Butleris, R. 2001. The approach for user requirements specification. In *5th East-European conference ADBIS-2001, Research Communications*. Vilnius, 225-240.

Cabot, J. and Gogolla, M. 2012. Object constraint language (OCL): a definitive guide. In *Formal methods for model-driven engineering*. Springer Berlin Heidelberg, 58-90.

Cant, M.C. and Wiid, J. A. 2013. Establishing The Challenges Affecting South African SMEs. *International Business & Economics Research Journal*, 12(6):707-716.

Cariou, E., Marvie, R., Seinturier, L. and Duchien, L. 2004.OCL for the specification of model transformation contracts. In *OCL and Model Driven Engineering, UML 2004 Conference Workshop.* 12 October 2004. 69-83.

Chakraborty, A. 2015. Impact of Poor Accounting Practices on the Growth and Sustainability of SMEs. *The International Journal Of Business & Management*, 3(5): 227- 231.

Charland, A. and Leroux, B. 2011. Mobile application development: web vs. native. *Communications of the ACM*, *54*(5): 49-53.

Chatterjee, S. 2015. ERP failure in developing countries: A case study in India. In *India Conference (INDICON), 2015 Annual IEEE*: IEEE, 1-6.

Chelimo, J. K. and Sopia, I. O. 2014. Effects of Bookkeeping on Growth of Small and Medium Business Enterprises in Kabarnet Town, Baringo County, Kenya. *International Journal of Science and Research*, 3(12):432-437.

Chimucheka, T. and Rungani, E. C. 2013. Obstacles to accessing finance by small business operators in the Buffalo City Metropolitan Municipality. *East Asian Journal of Business Management*, *3*(2): 23-29.

Clark, R., Studholme, O., Murphy, C. and Manian, D. 2012. *Beginning HTML5 and CSS3*. Apress.

Cleven, A., Gubler, P. and Hüner, K.M. 2009. Design alternatives for the evaluation of design science research artifacts. *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology*. USA: New York, 7-8 May 2009. ACM, 19.

Cole, R., Purao, S., Rossi, M., and Sein, M. K. 2005. Being Proactive: Where Action Research Meets Design Research. Twenty-Sixth International Conference on Information Systems, Las Vegas, USA: AIS, 325-336.

Cosh, A., Hughes, A. and Wood, E. 1998. Innovation surveys and very small enterprises. *ESRC Centre for Business Research Working Papers*.

Dagdilelis, V., Satratzemi, M. and Evangelidis, G. 2003. Implementing a nationwide system for training very small enterprises for ICT innovation: The Greek case. *Educational Technology & Society*, 6(1): 26-31.

Dalitso, K. and Peter, Q. 2000. The policy environment for promoting small and medium-sized enterprises in Ghana and Malawi. *University of Manchester*.

Dalvit, L., Kromberg, S. and Miya, M. 2014. The Data Divide in a South African Rural Community: A Survey of Mobile Phone Use in Keiskammahoek. *3rd National South African e-Skills Summit, Cape Town, South Africa*.

Dalmasso, I., Datta, S. K., Bonnet, C. and Nikaein, N. 2013. Survey, comparison and evaluation of cross platform mobile application development tools. In *Wireless Communications and Mobile Computing Conference (IWCMC), 9th International*. July 2013 IEEE, 323-328.

de Andrade, P.R., Albuquerque, A.B., Frota, O.F., Silveira, R.V. and da Silva, F.A. 2015. Cross platform app: a comparative study. *arXiv preprint arXiv:1503.03511*.

Deen-Swarray, M., Ndiwalana, A. and Stork, C. 2013. Bridging the financial gap and unlocking the potential of informal businesses through mobile money in four East African countries.

Delécolle, T. 2011. Very Small Enterprises as Professional Customers: a Qualitative Study. *International Business Research*: *4*(2): 20-30.

Demuth, B. 2009. OCL (Object Constraint Language) by Example. Department of Computer Science, Institute for Software and Multimedia Technology.

Devos, J., Van Landeghem, H. and Deschoolmeester, D. 2013, June. Narratives of an Outsourced Information Systems Failure in a Small Enterprise. In *International Working Conference on Transfer and Diffusion of IT* : 57-72. Springer Berlin Heidelberg.

Dinh, H.T., Lee, C., Niyato, D. and Wang, P. 2013. A survey of mobile cloud computing: architecture, applications, and approaches. *Wireless communications and mobile computing*, *13*(18): 1587-161.

DTI 2008. Annual Review of Small Businesses in South Africa 2005-2007. In: INDUSTRY, D. O. T. A. (ed.). Pretoria: Department of Trade and Industry.

Donner, J. and Escobari, M .X. 2010. A review of evidence on mobile use by micro and small enterprises in developing countries. *Journal of International Development*, *22*(5): 641-658.
Enterprises (SMEs) in the Tamale Metropolis of Ghana. *Research Journal of Finance and Accounting*, *5*(2): 107-117.

Duncombe, R. 2012. Understanding mobile phone impact on livelihoods in developing countries: A new research framework.

Đurković, O. and Raković, L. 2009. Risks in Information Systems Development Projects. *Management*, *4*(1): 013-019.

Eloho, A.R., ATU, O.G. and ATU, O.E.O.K. 2016. Financial Reporting for Small and Medium Scale Enterprises. *Igbinedion University Journal of Accounting, (2): 11-39.*

Esselaar, S., Stork, C., Ndiwalana, A. and Deen-Swarray, M. 2007. ICT usage and its impact on profitability of SMEs in 13 African countries. *Information Technologies & International Development*, 4(1): 87-100.

Ezejiofor, R. A., Emmanuel, E. and Olise, M. C. 2014. The Relevance of Accounting Records in Small Scale Business: The Nigerian Experience. *International Journal of Academic Research in Business and Social Sciences*, *4*(12): 69-82.

Falkena, H., Abedian, I., Von Blottnitz, M., Coovadia, C., Davel, G., Magungandaba, J and Rees, S. 2002. SME's access to finance in South Africa. *Pretoria, The Task Group of the Policy Board for Financial Services and Regulation*.

Fernando, N., Loke, S.W. and Rahayu, W. 2013. Mobile cloud computing: A survey. *Future generation computer systems*, *29*(1): 84-106.

Fatoki, O. 2014. The causes of the failure of new small and medium enterprises in South Africa. *Mediterranean Journal of Social Sciences*, *5*(20): 922.

Financial management practices in successful Small and Medium Enterprises (SMEs). *The Southern African Journal of Entrepreneurship and Small Business Management*, *7*(1): 88-116.

Flood, D., Harrison, R., Iacob, C. and Duce, D., 2012. Evaluating Mobile Applications: A Spreadsheet Case Study. *International Journal of Mobile Human Computer Interaction (IJMHCI)*, *4*(4): 37-65.

FNB 2016. FNB Banking App (Online). Available at : https://www.fnb.co.za/

FREEMAN, A. 2016. The MVC Pattern, Projects, and Conventions. In *Pro ASP. NET Core MVC*. Apress, 53-64.

Galloway, J., Haack, P., Wilson, B. and Allen, K.S. 2012. *Professional ASP. NET MVC 4*. John Wiley & Sons

Ganesh, L. and Mehta, A. 2010. Critical failure factors in enterprise resource planning implementation at Indian SMEs. *Asian Journal of Management Research*, 1(1):44-57.

Gatsou, C., Politis, A. and Zevgolis, D. 2012. The Importance of Mobile Interface Icons on User Interaction. *IJCSA*, *9*(3): 92-107.

Gavian, S., El-Meehy, T., Bulbul, L. and Ender, G. 2002. 18 The Importance of Agricultural Growth to SME Development and Rural Employment in Egypt. *Does Agricultural Policy Reform Work?*, 395.

Geerts, G. L. 2011. A design science research methodology and its application to accounting information systems research. *International Journal of Accounting Information Systems*, *12*(2): 142 -151.

Gilbert, K. A. 2013. Accounting Practices of SMEs: A Case Study of Kumasi Metropolis in Ghana. *International Journal of Business and Management*, 8(24): 73-83.

Gilmore, A., Carson, D. and Grant, K. 2001. SME marketing in practice. *Marketing intelligence & planning*, *19*(1): 6-11

Göktürk, E. 2011.What is "paradigm"? (Online). Available at: http://folk.uio.no/erek/essay/paradigm.pdf. (Accessed 29 September 2015).

Government Gazette. 2003. No. 26 of 2003: national small business amendment act 26, 2003. (Online). Available at: http://www.info.gov.za/view/DownloadFileAction?id=68002 (Accessed 2 January 2015).

Gruhn, V. and Köhler, A. 2007. Aligning Software Architectures of Mobile Applications on Business Requirements. In *WISM*.

Gugnani, V., Arora, K. and Shukla, V.N. 2006, December. Issues & challenges in developing multilingual applications for mobile: Indic languages perspective. In *W3C Workshop on the Mobile web in Developing Countries*.

Habra, N. 2001. Separation of concerns in software engineering education.

Habra, N., Alexandre, S., Desharnais, J.M., Laporte, C.Y. and Renault, A., 2008. Initiating software process improvement in very small enterprises: Experience with a light assessment tool. *Information and software technology*, *50*(7): 763-771.

Hadjimanolis A. 2000. A resource-based view of innovativeness in small firms. Technology Analysis & Strategic Management, 12(2): 263-281.

Hamacher, S. 2015. Exploring the Frugal Innovation Process.

Hanid, M. B. 2014. Design Science Research as an Approach to Develop Conceptual Solutions for Improving Cost Management in Construction. (Online). Ph.D, University of Salford, United Kingdom. Available: http://usir.salford.ac.uk/32050/1/Final_Thesis.pdf

Hartley, W. C. F., Firer, C and Ford, J.C. 1999. An introduction to Business Accounting for Managers. 4th ed. Butter-Heinemannn, Linarance, Jordan Hill, England.

Heitkötter, H., Hanschke, S. and Majchrzak, T.A. 2012. Evaluating cross-platform development approaches for mobile applications. In *International Conference on Web Information Systems and Technologies*. Berlin Heidelberg. Springer, 120-138.

Herrington, M., Kew, J., and Kew, P. 2009 Global Entrepreneurship Monitor, South Africa Report. (Online). Available at: http://www.gbs.nct.ac.za/gbswebb/userfiles/gemsouthafrica2000pdf. (Accessed 17 May 2015)

Hessels, J. 2008. Overcoming Resource Constraints Through Internationalization? An Empirical Analysis of European SMEs.

Hevner, A. R., March, S. T., Park, J. and Ram, S. 2004. Design science in information systems research. *MIS quarterly*, 28: 75-105.

Hinton, P., Mokobi, U. and Sprokel, C. 2006. Botswana small and medium enterprise under banked market research. *Enterprise banking group*.

Hishigsuren, G., Spahr, M., Estevez, I. and Magnoni, B. 2014. Experiences of Microfinance Institutions Serving Very Small to Small Enterprises in Latin America. *Enterprise Development and Microfinance*, *25*(3): 246-258.

Holtzblatt, K. and Beyer H. R. 2013.Contetxual Design. In: Soegaard, M and Dam, R.F. ed. *The Encyclopaedia of Human-Computer Interaction* (2nd Ed.). Aarhus: The Interaction Design Foundation.

Holzer and Ondrus. 2012. (Online). Available at: (http://www.janondrus.com/wp-content/uploads/2008/05/WEB2012.pdf). (Accessed 25 July 2015).

Hosman, L. and Fife, E., 2012. The use of mobile phones for development in Africa: Top-down-meets-bottom-up partnering. *The Journal of Community Informatics*: *8*(3).

Hossain, M. 2013. Adopting open innovation to stimulate frugal innovation and reverse innovation (online). Available at: https://ssrn.com/abstract=2197782 (Accessed 25 July 2016).

Huang, Z. and Palvia, P. 2001. ERP implementation issues in advanced and developing countries. *Business process management journal*, *7*(3):276-284.

Huang, W., Li, R., Maple, C., Yang, H. J., Foskett, D. and Cleaver, V. 2010. A novel life cycle model for Web-based application development in small and medium enterprises. *International Journal of Automation and Computing*, *7*(3): 389-398.

Hussain, I., Farooq, Z. and Akhtar, W., 2012. SMEs development and failure avoidance in developing countries through public private partnership. *African Journal of Business Management*, *6*(4):1581- 1589.

Hyvärinen, A., Keskinen, M. and Varis, O. 2016. Potential and Pitfalls of Frugal Innovation in the Water Sector: Insights from Tanzania to Global Value Chains. *Sustainability*, *8*(9): 888.

International Finance Corporation. 2014. Experiences of Microfinance institutions serving very small to small enterprises in Latin America: Based on Case Studies in LAC, Washington D.C.

International Monetary Fund. 2015. The Challenges of Financing SMEs. (Online). Available at:https://www.imf.org/external/np/seminars/eng/2015/brazzaville/pdf/AfrilandENG.pdf (Accessed 4 October 2016).

Irefin, I. A., Abdul-Azeez, I. A. and Tijani, A. A. 2012. An investigative study of the factors affecting the adoption of information and communication technology in small and medium scale enterprises in Nigeria. *Australian Journal of Business and Management Research*, 2(2):1-9.

Imedashvili, S., Kekua, A. and Ivchenko, P. 2013. Rural Entrepreneurship: Challenges and Opportunities.

Isaksson, C. 2013. HTML5-based Travel HabitApplication: Investigation of VectorWeb Mapping Possibilities.

Isomursu, M., Kuutti, K. and Väinämö, S. 2005. Experience Clip: Method for User Participation and Evaluation of Mobile Concepts. *In Proceedings Participatory Design Conference (PDC).*Toronto, 04 July 2005, Canada*: ACM, 83-92.*

Isomursu, M., Tähti, M., Väinämö, S. and Kuutti, K. 2007. Experimental evaluation of five methods for collecting emotions in field settings with mobile applications. *International Journal of Human-Computer Studies*, *65*(4): 404-418.

Jindrichovska, I. 2013. Financial management in SMEs. *European Research Studies*, *16*(4): 79.

Johnson, D. L., Zheleva, M., Belding, E. and Parks, L. 2012. Broadband Adoption in Rural Sub-Saharan Africa. *International Journal of Communication,* (6) 2467–2491

Jones, V. (2008). Record keeping and basic accounting (Online). Available at*:* http://ezinearticles.com/?Record-Keeping-and-Basic-Bookkeeping&id=1667595. (Accessed 23 March 2015).

Jonker, J. and Pennink, B. 2010. *The Essence of Research Methodology*, Heidelberg Dordrecht London New York: Springer.

Joorabchi, M. E., Mesbah, A. and Kruchten, P. 2013. Real challenges in mobile app development. In *Empirical Software Engineering and Measurement, International Symposium on*. 10 October 2013. ACM/IEEE, 15-24.

Kambalyal, C. 2010. 3-tier architecture. *Retrieved On*, *2*.

Kambwale, J. N. and Chisoro, C. 2015. Investigation into The Causes of Small and Medium Enterprise Failures In Windhoek, Namibia. *Arabian Journal of Business and Management Review (Oman Chapter)*, *4*(7): 80-109.

Kapurubandara, M., and Lawson, R. 2006. Barriers to Adopting ICT and e-commerce with SMEs in developing countries: an Exploratory study in Sri Lanka. *Collector (Collaborative Electronic Commerce Technology and Research)*.

Karadag, H. 2015. Financial management challenges in small and medium-sized enterprises: A strategic management approach. *Emerging Markets Journal*, *5*(1): 26.

Kaur, B. P. and Aggrawal, H. 2013. Critical failure factors in information system: An exploratory review. *Journal of global research in computer science*, *4*(1): 76-82.

Khalique, M., Isa, A.H.B.M., Shaari, N., Abdul, J. and Ageel, A. 2011. Challenges faced by the small and medium enterprises (SMEs) in Malaysia: An intellectual capital perspective. International Journal of Current Research 3(6): 398-401.

Khan, R. 2016. How Frugal Innovation Promotes Social Sustainability. *Sustainability*, *8*(10):2-29.

Kesper, A. 2001. Failing or not aiming to grow? Manufacturing SMMEs and their contribution to employment growth in South Africa. In *Urban forum:* Netherlands. 1 April 2001. Springer, 171-203.

Kim, H. K. and Gelogo, Y. E. 2013. Convergence Mobile Application Architecture on Requirement View. *Convergence*: *8*(3).

Kiveu, M. and Ofafa, G. 2013. Enhancing market access in Kenyan SMEs using ICT. *Global Business and Economics Research Journal*, *2*(9): 29-46.

Kjeldskov, J. and Stage, J. 2004. New techniques for usability evaluation of mobile systems. *International journal of human-computer studies*, *60*(5):599-620.

Kofi, M.E and Adjei, H. 2014. Assessing financial reporting practices among small scale enterprises in kumasi metropolitan assembly. *European Journal of Business and Social Sciences*, 2(10): 81-96.

Kojiv, M. 2014. ASP. MVC5 (Online). Available at: http://rti.etf.bg.ac.rs/rti/si3iep/vezbe-2014/ASP%20.NET%20MVC.pdf

Kontio, J., Lehtola, L. and Bragge, J. 2004. Using the focus group method in software engineering: obtaining practitioner and user experiences. In *Empirical Software Engineering, 2004. ISESE'04. Proceedings. International Symposium on.* 19 August 2004. IEEE,271-280.

Kovachev, D., Cao, Y. and Klamma, R. 2011. Mobile cloud computing: a comparison of application models. *arXiv preprint arXiv:1107.4940*.

Kuechler, B. and Vaishnavi, V., 2004. Design Science Research in Information Systems (Online). Available at: *http://www.desrist.org/design-research-in-information-systems* (Accessed 23 January 2015).

Kumar, A. 2014. Software Architecture Styles: A Survey. *International Journal of Computer Applications*: *87*(9).

Kung'u, G. K. 2011. Factors influencing SMEs access to finance: A case study of Westland Division, Kenya.

Kuyoro'Shade, O., Awodele, O., Alao, O. D. and Omotunde, A. A. 2013. ICT solution to Small and Medium Scale Enterprises (SMEs) in Nigeria. *International Journal of Computer and Information Technology*, 4(2):785-789.

Laporte, C.Y., Alexandre, S. and Renault, A., 2008. Developing international standards for very small enterprises. *Computer*, *41*(3):98-101.

Laporte, C.Y., O'Connor, R.V. and Paucar, L.H.G. 2015. Software engineering standards and guides for Very Small Entities implementation in two start-ups. *International Conference on Evaluation of Novel Approaches to Software Engineering (ENASE).* 29 April 2015. IEEE, 5-15.

Leadbeater, C. 2014. *The frugal innovator: Creating change on a shoestring budget*. Springer.

Lekhanya, L. M and Mason, R. B. 2013. The use of marketing strategies by small, medium and micro enterprises in rural KwaZulu-Natal. *The Southern African Journal of Entrepreneurship and Small Business Management*, 147(6): 39-56.

Levy, M. and Powell, P. 2004. *Strategies for Growth in SMEs: The Role of Information and Information Sytems*. Butterworth-Heinemann.

Liedholm, C. E and Mead, D. C. 2013. Small Enterprise and Economic Development: *The Dynamics of Micro and Small Enterprise.* Chicago: Routledge.

Lim, S. H. 2015. Experimental Comparison of Hybrid and Native Applications for Mobile Systems. *International Journal of Multimedia and Ubiquitous Engineering*, *10*(3): 1-12.

Linss, V. and Fried, A. 2010. The ADVIAN® classification—A new classification approach for the rating of impact factors. *Technological Forecasting and Social Change*, *77*(1), 110-119.

Linss, V. and Fried, A. 2009. Advanced Impact Analysis: the ADVIAN® method-an enhanced approach for the analysis of impact strengths with the consideration of indirect relations (Online). Available at: http://monarch.qucosa.de/fileadmin/data/qucosa/documents/5812/data/ADVIAN_method.pdf

Löfqvist, L. 2014. Product innovation in small established enterprises: Managing processes and resource scarcity (Online). Doctoral dissertation, KTH Royal Institute of Technology.

Löfqvist, Lars Gunnar. 2011. MANAGING RESOURCE SCARCITY IN SMALL ENTERPRISES´ DESIGN PROCESSES." In *DS 68-3: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design, Vol. 3: Design Organisation and Management, Lyngby/Copenhagen, Denmark.* 15-19 August 2011.

Lopez-Vega, H., Tell, F. and Sbragia, R. 2014. The role of Brazilian subsidiary R&D in Swedish MNEs:–towards tropicalized innovations?. *Management of innovation and technology*, (3):6-8.

MacDonald, M. 2010. *Beginning ASP.NET in C# 2010*. Apress.

Magennis, T. 2010. *LINQ to objects using C# 4.0: using and extending LINQ to objects and parallel LINQ (PLINQ)*. Pearson Education.

Maguire, M. and Bevan, N. 2002. User requirements analysis. In *Usability*. Springer US, 133-148.

Mahembe, E. 2011. Literature review on small and medium enterprises' access to credit and support in South Africa. *Underhill Corporate Solutions. National Credit Regulator (NCR): Pretoria, South Africa*.

Mairura, C. J. 2011. The Influence of Business records on Business Performance. *Journal of Language, Technology &Entrepreneurship in Africa, 3(1):* 133-144.

Majrashi, K. and Hamilton, M. 2015. A cross-platform usability measurement model. *Lecture Notes on Software Engineering*, *3*(2): 132-144.

Malan, R. and Bredemeyer, D. 2001. Defining non-functional requirements.

Manuere, Faitira, E. Gwangwava, and K. Gutu. 2012. "Barriers to the adoption of ICT by SMEs in Zimbabwe: an exploratory study in Chinhoyi District." *Interdisciplinary Journal of Contemporary Research in Business* 4, no. 6: 1142-1156.

March, S.T. and Smith, G.F. 1995. Design and natural science research on information technology. *Decision support systems*, *15*(4): 251-266.

Marjanova, T. and Stojanovski, M. 2012. Marketing knowledge and strategy for SMEs: Can they live without it? *Thematic Collection of papers of international significance:" Reengineering and entrepreneurship under the contemporary conditions of enterprise business"*: 131-143.

Marosi, I. and Katona, F. 2015. Businesses and Their Attitudes to Frugal Innovation. *Acta Universitatis Sapientiae, Economics and Business*, *3*(1): 81-91.

Maseko, N. and Manyani, O. 2011. Accounting practices of SMEs in Zimbabwe: An investigative study of record keeping for performance measurement (A case study of Bindura). *Journal of Accounting and Taxation*, *3*(8): 171-18.

Masi, E., Cantone, G., Mastrofini, M., Calavaro, G. and Subiaco, P. 2012. Mobile apps development: A framework for technology decision making. In *International Conference on Mobile Computing, Applications, and Services*, Berlin Heidelberg. Springer, 64-79.

Mazza, R. and Berre, A. 2007 Focus group methodology for evaluating information visualization techniques and tools. In *Information Visualization, 2007. IV'07. 11th International Conference*. 4 July 2014. IEEE, 74-80.

Mazzarol, T., Reboud, S. and Clark, D. 2015. The financial management practices of small to medium enterprises. In *Small Enterprise Association of Australia and New Zealand 28th Annual SEAANZ Conference Proceedings*: 1-3.

Mbayen, M. 2013. A Mobile Application Development Strategy-Finding Model.

Mbedzi, K. P. 2011. *The role of government agencies in promoting SMME's in Limpopo: a critical assessment* (Doctoral dissertation, Stellenbosch: University of Stellenbosch).

Mbonyane, B. L. 2009. An Exploration of Factors that Lead to Failure of Small Businesses in the KagisoTownship. *College of Economic and Management Sciences.*

Mbroh, J. K and Attom, B. E. (2013).Accounting and Control Systems Practiced By Small and Micro Enterprise Owners within the Cape Coast Metropolitan Area of Ghana. *Asian Journal of Business and Management Sciences,* 1(9): 28-47.

Mbuyisa, B. and Leonard, A. 2015. ICT adoption in SMEs for the alleviation of poverty. In *International Association for Management of Technology, IAMOT 2015 Conference Proceedings*.

Mcgrath, S., Martins, J., Smith, J., Cachalia, F. and Kane, K. 2005. Skills development in South Africa's very small and micro enterprise sector. *Journal of Vocational Education and Training, 57*(4): 499-517.

Mintah, E. K., Adjei, H., Mintah, C. O. and Okofo, C. A. 2014. Assessing Financial Reporting Practices Among Small Scale Enterprises in Kumasi Metropolitan Assembly. *European Journal of Business and Social Sciences, 2*(10): 81-96.

Moyi, E. D. 2003. Networks, information and small enterprises: New technologies and the ambiguity of empowerment. Information Technology for Development, 10(4): 221-232.

Mocanu, A.M., Litan, D., Olaru, S. and Munteanu, A. 2010. Information systems in the knowledge based economy. *WSEAS Transactions on Business and Economics, 7*(1): 11-21.

Muchira, B. W. 2013. Record Keeping and Growth of Micro and Small Enterprises, A Case study of Thika Municipality in Kenya (online). PhD. Kenyatta University. Available: http://irlibrary.ku.ac.ke/bitstream/handle/123456789/7122/Bancy%20Wawira%20Muchira.pdf?sequence=1.

Muchira, B. W and Ambrose J. 2014. Record Keeping and Growth of Micro and Small Enterprises: An Empirical Study of MSES in Selected Urban Centres in Kenya. *Global Joiurnal of Commerce and Management Perspective*, 3(6): 79-87.

Mukwasi, C. M. and Seymour, L. F. 2014. The growing trend of small to medium-sized enterprises adopting enterprise resource planning systems: an analysis of business cases in Zimbabwe and South Africa. *Journal of Emerging Trends in Economics and Management Sciences*, *5*(7): 138.

Musah, A. and Ibrahim, M. 2014. Record Keeping and the Bottom Line: Exploring the Relationship between Record Keeping and Business Performance among Small and Medium

Mintah, E. K., Adjei, H., Mintah, C. O. and Okofo, C. A. 2014. Assessing Financial Reporting Practices Among Small Scale Enterprises in Kumasi Metropolitan Assembly. *European Journal of Business and Social Sciences*, *2*(10): 81-96.

Mistry, R. and Misner, S. 2014. *Introducing Microsoft SQL Server 2014*. Microsoft Press.

Mutaz, M. A. 2010. The Design and Engineering of Innovative Mobile Data Services: An Ontological Framework Found in Business Thinking (Online). Ph.D, Brunel University London. Available at: http://bura.brunel.ac.uk/handle/2438/4397. (Accessed 23 September 2016).

Mutezo, A. T., 2009. *Obstacles in the access to SMME finance: an empirical perspective on Tshwane* (Doctoral dissertation).

Mutua, J. M. 2015. Effect Of Bookkeeping On The Growth Of Small And Medium Enterprises In Chuka Town. *European Journal of Business and Social Sciences*, *4*(07): 102-112.

Mpiti, M.N. and Rambe, P. 2016. THE INFLUENCE OF PUBLIC FINANCE ON THE PERFORMANCE OF SMMEs IN THE FREE STATE: A CASE OF AFRO HAIR SALONS IN MANGAUNG METROPOLITAN MUNICIPALITY. *Proceedings of the 28th Annual Conference of the Southern African Institute of Management Scientists*. 436-449

Mwangangi, S. M., Charles, O. and Odote, G. 2014. Role of Information and Communication Technology Solutions on the Growth of Small and Medium Enterprises: Case of Nairobi County. *International Journal of Academic Research in Business and Social Sciences,* 4(9): 385.

Nafeeseh, R. and Al-Mudimigh A. S. (2011). Justifying ERP Investment: The Role and Impacts of Business Case A Literature Survey. *International Journal of Computer Science and Network Security,* 11 (1) 185-193.

Nejadirani, F., Behravesh, M. and Rasouli, R. 2011. Developing countries and electronic commerce the case of SMEs. *World Applied Sciences Journal, 15*(5): 756-764.

Nayebi, F., Desharnais, J. and Abran, A. 2012. The State of the Art of Mobile Application UsabilityEvaluation. Canadian*Conference on Electrical and Computer Engineering (CCECE)*. Canada, 25 May 2012: *IEEE*, 1-4.

Ndhlovu, B. N. 2013. Lightweight Framework for Mobile Documentation of Very Small Enterprise Business Transactions. (Online). M.Tech, Durban University of Technology. Available at: http://ir.dut.ac.za/handle/10321/1163. (Accessed 09 September 2015)

Ngoepe, M. S. 2011. An Exploration of Records Management Trends in the South African Public Sector: A Case Study of the Department of Provincial and Local Government. M.sc. University of South Africa.

Njau, J.E. and Njuga, G.O. 2015. Mobile Phones Usage in Micro Enterprise in Tanzania and its Impact on Their Performance A Case of Micro Enterprises in Moshi Municipality, Tanzania. *International Journal of Economics, Commerce and Management*, *3*(6): 1047-1057.

Nyanga, T., Zirima, H., Mupani, H., Chifamba, E. and Mashavira, N. 2012. Survival of the Vulnerable: Strategies Employed By Small to Medium Enterprises in Zimbabwe to Survive an Economic Crisis. *Journal of Sustainable Development in Africa*, *15*(6).

O'Connor, R.V., Basri, S. and Coleman, G. 2010. Exploring managerial commitment towards SPI in small and very small enterprises. *Systems, software and services process improvement*, 268-279.

Ogunyemi, O.F. and Olofinsao, A.2014A Case Study Analysis of Factors (Success and Failure) Affecting Enterprise Resource Implementation Planning System in Nigeria.

Ohachosim, C. I., Onwuchekwa, F. C. and Ifeanyi, T. T. 2013. Financial Challenges of Small and Medium-Sized Enterprises (SMEs) in Nigeria: The Relevance of Accounting Information. *Review of Public Administration and Management*, *1*(2): 248-276.

Okpara, J. O. 2011. Factors constraining the growth and survival of SMEs in Nigeria: Implications for poverty alleviation. *Management Research Review*, *34*(2): 156-171.

Olawale, F. and Garwe, D. 2010. Obstacles to the growth of new SMEs in South Africa: A principal component analysis approach. *African journal of Business management*, *4*(5):729-738.

Olubusola, A.O. User satisfaction in mobile applications.

Olugbara, O.O. 2014. Stimulating the Growth of Creative Industries Very Small Enterprises through Frugal Information Systems Deployment. The Future of ICT for Creativity and Creative Industries, Innovation Hub Conference Centre, Pretoria, South Africa.

Olugbara, O. O and Ndhlovu, B. N. 2014. Constructing Frugal Sales System for Small Enterprises. *The African Journal of Information Systems*, *6*(4): 120-139.

Olugbara, O. O. and Ndhlovu, B. N. 2014. Constructing a Frugal Information Sales System for Small Entreprises. *The African Jornal of Information Systems* (Online). 6(4). Avaliable at: http://digitalcommons.kennesaw.edu/ajis/vol6/iss4/1/. (Accessed 26 August 2014)

Olugbara, O.O., Ojo, S.O. and Mphahlele, M.I. 2010. Exploiting image content in location-based shopping recommender systems for mobile users. *International Journal of Information Technology & Decision Making*, *9*(05) : 759-778.

Olukotun, A. G., James, S. O., and Olore, I. 2012. The Roles of Record Keeping In the Survival and Growth of Small Scale Enterprises in Ijumu Local Government Area of Kogi State. *Global Journal of Management and Business Research,* 12(13): 56-66.

Oluwatosin, H.S. 2014. Client-server model. *IOSR Journal of Computer Engineering (IOSR-JCE),* 16(1): 67-71.

Ongori, H. and Migiro, S. O. 2010. Information and communication technologies adoption in SMEs: literature review. *Journal of Chinese Entrepreneurship*, *2*(1): 93-104.

Onyango, Rapudo A., Raymond W. Ongus, Fredrick M. Awuor, and Constantine Nyamboga. 2014. Impact of Adoption and Use of Mobile Phone Technology on the Performance of Micro and Small Enterprises in Kisii Municipality Kenya.*World Journal of Computer Application and Technology* 2(2) 34-42.

Palser, S. 2011. Mobile Accounting System for Micro and Small Enterprise (MSEs) in the Developing World Literature Synthesis. (Online). Available at: http://people.cs.uct.ac.za/~rmulder/ispaza/files/Literature_Survey_Mobile_Bookkeeping.pdf (accessed 24 June 2015).

Palser, S. and Marsden, G. 2011. Mobile Bookkeeping Application for Micro Entrepreneurs in the Developing World.

Papulová, Z. and Mokroš, M., 2007. Importance of managerial skills and knowledge in management for small entrepreneurs. *E-leader, Prague*: 1-8.

Parry, Z.B. 2009. Digital manipulation and photographic evidence: defrauding the courts one thousand words at a time. *U. Ill. JL Tech. & Pol'y*, 175-202.

Parida, V., Johansson, J., Ylinenpää, H. and Braunerhjelm, P. 2010. Barriers to Information and Communication Technology Adoption in Small Firms: Past Experiences, Current Knowledge and Policy Implications. Swedish Entrepreneurship Forum.

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

Peffers, K., Rothenberger, M., Tuunanen. And Vaezi R. 2012. Design Science Research Evaluation. In: ed. *Design Science Research in Information Systems. Advances in Theory and Practice.* Springer Berlin Heidelberg: 398-410.

Pejovic, V., Johnson, D.L., Zheleva, M., Belding, E., Parks, L. and van Stam, G. 2012. Broadband Adoption| The Bandwidth Divide: Obstacles to Efficient Broadband Adoption in Rural Sub-Saharan Africa. *International Journal of Communication*, *6*, 2467–2491.

Prat, N., Comyn-Wattiau, I. and Akoka, J. 2014. June. Artifact Evaluation in Information Systems Design-Science Research-a Holistic View. In *PACIS*. 15 June 2014. 23-40.

Pries-Heje, J., Baskerville, R. and Venable, J. 2008. Strategies for design science research evaluation. *ECIS 2008 proceedings*: 1-12.

Prystupa, K. and Rządca, M. 2015. Outsourcing failures in SME's: Case study approach. *Problems of Management in the 21st Century*, *10*(1) :37-47.

Dixit, A.K. and Prakash, O. 2011. A study of issues affecting ERP implementation in SMEs. *Researchers World*, *2*(2): 77.

Quispe, A., Marques, M., Silvestre, L., Ochoa, S.F. and Robbes, R. 2010. Requirements engineering practices in very small software enterprises: A diagnostic study. In *XXIX*

International Conference of the Chilean Computer Science Society. 15 November 2010. IEEE, 81-87.

Radjou, N. and Prabhu, J. 2015. Frugal Innovation: How to do more with less. *The Economist*.

Rajapakse, J. and Seddon, P. B. 2005. Why ERP may not be suitable for organizations in developing countries in Asia. *Proceedings of PACIS*, 1382-1388.

Rathnasiri, M.U. 2014. Financial Reporting Practices of Small and Medium Enterprises (SMEs) in Sri Lanka. *South East Asia Journal of Contemporary Business, Economics and Law*, 4(1): 15-24.

Roe, D., Broda, K. and Russo, A. 2003. *Mapping UML models incorporating OCL constraints into Object-Z*. Imperial College of Science, Technology and Medicine, Department of Computing.

Rosenbaum, S., Cockton, G., Coyne, K., Muller, M. and Rauch, T. 2002. Focus groups in HCI: wealth of information or waste of resources?. In *CHI'02 extended abstracts on human factors in computing systems*. 20 April 2002. ACM,702-703.

Rossi, M., and Sein, M. K. 2003. Design research workshop: a proactive research approach. 26th Information Systems Research Seminar in Scandinavia, Haikko Finland: The IRIS Association.

Rugut, M.J. 2012. *Marketing strategies adopted by small and medium enterprises in Nairobi central business district* (Doctoral dissertation).

SBP 2014. Examining the challenges facing small businesses in South Africa (Online). Available at: http://www.sbp.org.za/uploads/media/SBP_Alert_-_Examining_the_challenges_facing_small_businesses_in_SA_01.pdf

Sakurai, M., Watson, R. T., Abraham, C. and Kokuryo, J. 2014. Sustaining life during the early stages of disaster relief with a frugal information system: Learning from the great east Japan earthquake. *Communications Magazine, IEEE*, *52*(1): 176-185.

Salikin, N., Ab Wahab, N. and Muhammad, I. 2014. Strengths and Weaknesses among Malaysian SMEs: Financial Management Perspectives. *Procedia-Social and Behavioral Sciences*, (*129*): 334-340.

Sam, M., Fazli, M., Hoshino, Y. and Tahir, M. N. H. 2012. The Adoption of Computerized Accounting System in Small Medium Enterprises in Melaka, Malaysia. *International Journal of Business and Management*: *7*(18).

Sedbrook, T. and Newmark, R. I. 2008. Automating REA policy level specifications with semantic web technologies. *Journal of Information Systems :Fall 2008*, 22(2): 24–77.

Seeletse, S. M. 2012. Common causes of small businesses failure in the townships of West Rand district municipality in the Gauteng Province of South Africa. *African Journal of Business Management*, *6*(44): 10994

Selioukova, Y. 2001. Business Process Modeling in Software Requirements Engineering for Small and Medium Software Projects.

Sharkie, C. and Fisher, A. 2013. *Jump Start Responsive Web Design*. SitePoint.

Sharma, M., Chaudhary, V., Bala, R. and Chauhau, R. 2013. Rural entrepreneurship in developing countries: Challenges, problems and performance appraisal. *Global Journal of Management Business studies*, *3*(9): 1035-1040.

Sharma, S. 2012. Very Small Enterprises in Nepal. *National Labour Academy*. (Online). Available at: http://www.cmi.no/file/?2172 (Accessed 17 June 2015).

Simula, H., Hossain, M. and Halme, M. 2015. Frugal and Reverse Innovations – Quo Vadis? (online). Available at : https://ssrn.com/abstract=2678861 or http://dx.doi.org/10.2139/ssrn.2678861

Sjauw-Koen-Fa, A. and Vereijken, I. 2005. Access to financial services in developing countries. *Rabobank Nederland, September*, 1-32.

Sonnenberg, C. and vom Brocke, J. 2012. Evaluations in the science of the artificial–reconsidering the build-evaluate pattern in design science research. In *Design Science Research in Information Systems. Advances in Theory and Practice*, Springer Berlin Heidelberg, 381-397.

South Africa. 2003. *National Small Business Act*. Government Gazette: 26 November (online). Available at: http://www.saflii.org/za/legis/num_act/nsbaa2003331.pdf (Accessed 23 July 2014).

Stanciu, V. and Tinca, A. 2013. ERP solutions between success and failure. *Accounting and Management Information Systems*, *12*(4): 626.

Sun, Y., Cao, H., Tan, B. and Shang, R. A. 2016. Developing Frugal IS Innovations: Applied insights from Weqia. *International Journal of Information Management*, *36*(6): 1260-1264.

.

Taiwo, M. A., Ayodeji, A. M. and Yusuf, B. A. 2012. Impact of small and medium enterprises on economic growth and development. *American journal of business and management*, *1*(1): 18-22.

Taiwo, J. Taiwo N., Falohun, T. O. and Agwu, M. E. 2016. SMEs financing and its effects on Nigerian economic growth. *European Journal of Business, Economics and Accountancy*, *4*(4).

Takeda, H., Veerkamp, P., Tomiyama, T., and Yoshikawam, H. , 1990. Modeling Design Processes.*AI Magazine*, 37-48.

Takhar, A., Chitakunye, P. and Fields, Z. 2013. SMS Marketing: An Emergent Trend within SMEs. *Marketing in the Cyber Era: Strategies and Emerging Trends: Strategies and Emerging Trends*, 37.

Tambovcevs, A. and Tambovceva, T. 2013. ERP system implementation: benefits and economic effectiveness. *Publication. editionName*: 215-221.

Tan, F. T. C., Ky, D. and Tan, B. 2016. Toward a Process Theory of IT-Enabled Frugal Innovation: The Role of Organizational Bricolage in Kofu Singapore.

Tegarden, D.P., Sheetz, S.D. and Monarchi, D.E. 1995. A software complexity model of object-oriented systems. *Decision Support Systems, 13*(3-4): 241-262.

Tang, Y. 2014. Trade credit and profitability in small and medium enterprises (Online). Bachelor's Degree, University of Twente. Available : http://essay.utwente.nl/65357/1/Tang_MB_IBA.pdf

Tiwari, R. 2016. India's potential as a lead market for frugal innovation and the role of socio-cultural context factors.

Tiwari, R. and Herstatt, C. 2012. Open Global Innovation Networks as Enablers of Frugal Innovation: Propositions Based on Evidence from India. Hamburg, Germany. *Institute for Technology and Innovation Management Working Paper, Hamburg, Germany*.

Tobora, O.O. 2015. Challenges faced by entrepreneurs and the performance of small and medium scale (SMEs) In Nigeria: An Intellectual capital issue. *International Letters of Social and Humanistic Sciences (ILSHS), 1*: 32-40.

Trivedi, M.C. and Khanum, M.A. 2012. Role of context in usability evaluations: A review. *Advanced Computing: An International Journal (ACIJ*), 3(2):69-78.

Tun, P. M. 2014. Choosing a mobile application development approach. *ASEAN Journal of Management and Innovation*: 69-74.

Turyahebwa, A., Sunday, A. and Ssekajugo, D. 2013. Financial management practices and business performance of small and medium enterprises in western Uganda. *African journal of business management, 7*(38): 3875 -3885.

TutorialsPoint. 2014. Bootstrap responsive web development (Online). Available at: https://www.tutorialspoint.com/bootstrap/bootstrap_tutorial.pdf

Tustin, D. H. 2003. Skills audit of micro and very small business enterprises in Northern Tshwane: an exploratory study. *Southern African Business Review*, 7(2): 36-45.

Underhill Corporate Solutions. 2011. Literature Review on Small and Medium Enterprises' Access to Credit and Support in South Africa. (Online). Available at: http://www.underhillsolutions.co.za. (Accessed 3 March 2015).

Upadhyay, P., Basu, R., Adhikary, R. and Dan, P. K. 2010. A comparative study of issues affecting ERP implementation in large scale and small medium scale enterprises in India: A Pareto approach. *International Journal of Computer Applications*, *8*(3): 23-28.

Vaishnavi, V. and Kuechler, B. 2013. Design Science Research in Information Systems (Online). Available at: http://desrist.org/desrist/content/design-science-research-in-information-systems.pdf. (Accessed 11 May 2015).

Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W. and De Rochemont, M. 2009. Open innovation in SMEs: Trends, motives and management challenges. *Technovation, 29*(6): 423-437.

Van Scheers, L. 2011. SMEs' marketing skills challenges in South Africa. *African Journal of Business Management*, *5*(13): 5048-5056.

Venable, J., Pries-Heje, J. and Baskerville, R. 2012. A comprehensive framework for evaluation in design science research. In *Design Science Research in Information Systems. Advances in Theory and Practice*: Springer Berlin Heidelberg, 423-438.

Vermesan, O. and Friess, P. eds. 2013. Internet of things: converging technologies for smart environments and integrated ecosystems. River Publishers.

Vijayalakshmi, S., Zayaraz, G. and Vijayalakshmi, V. 2010. Multicriteria decision analysis method for evaluation of software architectures. *International Journal of Computer Applications*, *1*(25): 22-27.

Volker Gruhn, V. and Kohler, A. 2007. Aligning Software Architectures of Mobile Applications on Business Requirement. *Web Information Systems Modeling*. WISM'06: 1113-1124.

Watson, R.T. 2013. Africa's contributions to information systems. *The African Journal of Information Systems, 5*(4):126-130.

Watson, R. T., Kunene, K. N. and Islam, M. S. 2013. Frugal information systems (IS). *Information Technology for Development*, *19*(2): 176-187.

Wahyuni, D. 2012. The research design maze: understanding paradigms, cases, methods and methodologies, *Journal of Applied Management Accounting Research*, 10(1): 69-80.

Wang, Y. 2016. What are the biggest obstacles to growth of SMEs in developing countries?–An empirical evidence from an enterprise survey. *Borsa Istanbul Review*, *16*(3): 167-176.
Wang, Q. and Yang, Z. 2012. A method of selecting appropriate software architecture styles: quality Attributes and analytic hierarchy process.

Wegmann, A. and Genilloud, G. 2000. The role of "Roles" in use case diagrams. In *International Conference on the Unified Modeling Language*. Berlin, Heidelberg. 2 October 2000. Springer, 210-224.

White, G. R., Afolayan, A. and Plant, E. 2014. Challenges to the adoption of e-commerce technology for supply chain management in a developing economy: a focus on Nigerian SMEs. In *E-commerce Platform Acceptance*: 23-39. Springer International Publishing.

Wiegers, K. and Beatty, J. 2013. *Software requirements*. Pearson Education.

Wolf, S. 2001. Determinants and impact of ICT use for African SMEs: Implications for rural South Africa.). Annual Forum. Centre for Development Research (ZEF Bonn), Bonn University, TIPS. Diversifying participation in network development.

Wolmarans, H. P. and Meintjes, Q. 2015. Financial management practices in successful Small and Medium Enterprises (SMEs). *The Southern African Journal of Entrepreneurship and Small Business Management*, *7*(1): 88-116.

Wong, A., Scarbrough, H., Chau, P. and Davison, R. 2005. Critical failure factors in ERP implementation. *PACIS 2005 Proceedings*: 40.

Woschke, T., Haase, H. and Kratzer, J. 2017. Resource scarcity in SMEs: effects on incremental and radical innovations. *Management Research Review*: *40*(2): 195-217.

Xanthopoulos, S. and Xinogalos, S. 2013. A comparative analysis of cross-platform development approaches for mobile applications. In *Proceedings of the 6th Balkan Conference in Informatics*. 19 September 2013. ACM, 213-220.

Yahya, A. Z., Othman, M. S. and Shamsuri, A. L. S. 2012. The impact of training on small and medium enterprises (SMEs) performance. *Journal of Professional Management*, *2*(1): 15-25.

Yao, W., 2014. *Unleashing the full potential of SMEs: beyond financing*. Working Paper, 27 June. Hong Kong: Asia Global Institute, 1-46.

Zapata, M.I.B., Brito, A.E.P. and Triay, J.H.B. 2014. Financial Management in the Family and Non-Family Sme's in the Textile Industry in Mexico. *Accounting & Taxation*, *6*(2): 49-57.

Zayaraz, G. and Thambidurai, P. 2005. December. Software architecture selection framework based on quality attributes. In *INDICON, 2005 Annual IEEE*: 167-170.

Zeschky, M. B., Winterhalter, S. and Gassmann, O. 2014. From cost to frugal and reverse innovation: Mapping the field and implications for global competitiveness. *Research-Technology Management*, *57*(4): 20-27.

Zowghi, D. and Coulin, C. 2005. Requirements elicitation: A survey of techniques, approaches, and tools. In *Engineering and managing software requirements.* Springer Berlin Heidelberg, 19-46.