The ubiquitous and pervasiveness of mobile devices is transforming business performance in the world. This book explores the activities, strategies, business skills of street traders in Tanzania and developed a mobile application to overcome bookkeeping challenge. The designed app enables street traders to fix reasonable selling prices, evaluate cash and stock flow, prepare profit and loss reports, make informed business decision, and access various supportive services. Additionally, this book offered several future technology tracks to improve street traders' business.
MOBILE TECHNOLOGY FOR STREET TRADERS IN TANZANIA
MOBILE TECHNOLOGY FOR STREET TRADERS IN TANZANIA

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ABSTRACT

Street trade is an ancient and important category of informal occupation found everywhere in the developing world. It is an important source of income and livelihood for poor and less educated people merely because one can do it with relatively low capital and education. Despite many research in street trade there is a paucity of knowledge about how street traders conduct business in terms of business skills, strategies, and the use of technology to improve their undertakings. Most of the available literature on street trade focuses on socioeconomic factors and the challenges encountered and little on improving their activities, particularly through Information and Communication Technology (ICT). Theoretical and empirical studies have demonstrated the importance of ICT to small enterprises in fostering productivity, growth, efficiency and competitiveness. However, there are few ICT projects targeting street traders. ICT devices, particularly mobile phones, have become popular among small enterprises in Africa; however, their use is embedded in existing relations of social support and little in business improvement.

The main research interest of this thesis is to explore street traders’ activities, strategies and skills in order to design and develop mobile interventions for improving their business. The study followed the design science framework developed by Johannesson and Perjons (2014). Data was collected from Dar es Salaam, Dodoma and Joensuu, Finland. The thesis employed an exploratory sequential mixed methods approach where the qualitative data was followed up by quantitative data (Creswell, 2014). The systematic literature review was carried out in research paper four (PIV). A total of 313 street traders (Dar es Salaam and Dodoma), 12 business lecturers from the College of Business Education Dodoma Campus (CBE), and 17 PhD and Masters students from the University of Eastern Finland Joensuu Campus (UEF) were involved in the project. Data was collected through personal interviews, focus group
discussions, surveys, and documentary review. Data analysis was done through qualitative content analysis and descriptive statistics.

The findings show that street vendors operate in a challenging environment, possess low levels of business skills in all domains of business, and make most of their decisions based on tacit knowledge. Traders are restrained by unreliable business information, weak business strategies, lack of capital, and absence of record keeping. This thesis resulted in a successful design, development, and demonstration of the first version of the bookkeeping application for street traders’ bookkeeping, ready for further Design Science Research (DSR) projects. The findings suggest the possibility of intercultural co-creation activities within limited resources. In addition, the findings show a low level of ICT uptakes by informal workers, scarce use of user-centered design principles, lack of design science research approaches, and uneven distribution of ICT solutions among different types of informal workers.

*Universal Decimal Classification: 621.395.721.5*

*Library of Congress Subject Headings: Street vendors; Informal sector (Economics); Information technology; Mobile apps; Cell phones; Developing Countries; Sub-Saharan Africa; Tanzania*

*Yleinen suomalainen asiasanasto: katukauppa; epävirallinen talous; tietotekniikka; mobiilisovellukset; matkapu matkapuhelimet; kehitysmaat; Afrikkka; Tansania*
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In the first place, I thank the almighty God for the wisdom and the many blessings he bestows on me.

Secondly, all I would like to give my sincere thanks to my supervisors, Prof. Markku Tukiainen, and Dr. Mikko Apiola whose guidance and insight provoked critical thinking and made me to focus. Their incessant support, guidance, counselling, patience, enormous knowledge, and motivation made this PhD project successfully. Special mention goes to my first supervisor Prof. Erkki Sutinen, who was the first person to introduce to me the idea of mobile technology to street traders. In the beginning it was hard to accept it, but afterward it became very interesting and enjoyable.

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I would like to convey my heartfelt thanks to my fellow PhD candidates; Ezira, Geoffrey, William, Alsen, Anna, Mzomwe, and Joel for their wonderful contributions especially during the group presentations. Many thanks to Jesse Tulilahti for his effort to design and develop the mobile application for street traders bookkeeping which is an important pillar of this research.

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Dodoma, 14th June 2018
Nasibu Rajabu Mramba.
**LIST OF ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBE</td>
<td>College of Business Education</td>
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<tr>
<td>DESRIST</td>
<td>Design Science Research in Information Systems and Technology</td>
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<td>DSR</td>
<td>Design Science Research</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GPS</td>
<td>Global Positioning System</td>
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<td>ICT</td>
<td>Information and Communication Technology</td>
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<td>ICT4D</td>
<td>Information and Communication Technology for Development</td>
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<tr>
<td>M4D</td>
<td>Mobile Phone for Development</td>
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<tr>
<td>SMS</td>
<td>Short Message Services</td>
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<tr>
<td>SSA</td>
<td>Sub-Saharan Africa</td>
</tr>
<tr>
<td>TCRA</td>
<td>Tanzania Communication Regulatory Authority</td>
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<tr>
<td>UEF</td>
<td>University of Eastern Finland</td>
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<tr>
<td>USSD</td>
<td>Unstructured Supplementary Service Data</td>
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LIST OF ORIGINAL PUBLICATIONS

This thesis is based on data presented in the following articles, referred to by the Roman numerals I–IV.


AUTHOR’S CONTRIBUTION

I. For research paper one (PI), the present author drafted the research setting, conducted the interviews, analysed the data and developed the draft of the research paper. Other authors were involved in reviewing the study plan and editing the final version of the paper. In total, the current author contributed around 90% of the paper.

II. Research paper two (PII) is a continuation to research paper one. In PII the current author designed the research plan, including developing a questionnaire with 100 items, training data collectors and participating physically in the data collection. The current author performed data cleaning, data entry and almost 90% of the data analysis. Again, the current author drafted the first round of research findings in collaboration with other authors. The co-authors were greatly involved in the discussion of the findings, particularly in regard to technology interventions. The workshop with UEF students was conducted by the current author together with the UEF Computing Department staff.

III. In research paper three (PIII), the present author designed the research setting, organised the participants for the design project, collected data from the participants and wrote the draft of the paper. Other authors developed the mobile application for street traders’ bookkeeping and participated in roughly 20% of the research report writing and editing.

IV. In research paper four (PIV), the current author drafted the research plan and participated in collecting secondary data, data analysis and research report writing. Other authors were used to edit, comment and oversee the quality of the paper. In general, the current author contributed around 80% of the paper.
CONTENTS

ABSTRACT ................................................................................................................. 7

ACKNOWLEDGEMENTS ........................................................................................... 9

1 INTRODUCTION ...................................................................................................... 19
  1.1 Background and motivation for the research ................................................. 19
  1.2 Research questions .......................................................................................... 22
  1.3 Thesis structure ................................................................................................ 23
  1.4 Definitions of key concepts ............................................................................. 24

2 METHODS: DESIGN SCIENCE RESEARCH ..................................................... 27
  2.1 Introduction ....................................................................................................... 27
  2.2 Philosophical assumptions .............................................................................. 29
  2.3 Intercultural co-design ..................................................................................... 31
  2.4 Conclusion to DSR ........................................................................................... 32

3 PROBLEM EXPLICATION ...................................................................................... 33
  3.1 Chapter introduction ....................................................................................... 33
  3.2 Research on street trading ............................................................................. 33
      3.2.1 Research perspectives ............................................................................. 35
  3.3 Qualitative research (PI) ............................................................................... 37
      3.3.1 Overview results of PI ........................................................................... 38
      3.3.2 Conclusions of PI ................................................................................... 40
  3.4 Quantitative research (PII) ........................................................................... 41
      3.4.1 Overview of results in PII ..................................................................... 42
      3.4.2 Conclusions of PII ................................................................................. 44
  3.5 Problem explication: Conclusions .................................................................. 46

4 REQUIREMENT DEFINITION ............................................................................... 51
  4.1 Chapter introduction ....................................................................................... 51
  4.2 Generating ideas (PII) .................................................................................... 52
      4.2.1 Workshop description ............................................................................. 52
      4.2.2 Workshop results .................................................................................... 53
      4.2.3 Proposed platform ................................................................................... 55
      4.2.4 Discussion ............................................................................................... 56
  4.3 Topic selection and technology review ........................................................... 56
      4.3.1 Technology review ................................................................................. 57
  4.4 Defining requirements (PIII) ........................................................................... 58
      4.4.1 Workshop 1 ............................................................................................. 61
      4.4.2 Workshop 2 ............................................................................................. 62
1 INTRODUCTION

This chapter provides background information about the informal sector and street trade. It also presents the research problem, research questions, overview of the current project and definitions of the key terms.

1.1 BACKGROUND AND MOTIVATION FOR THE RESEARCH

In many developing countries, the informal sector is larger than the formal sector. The informal sector includes all activities that are not registered, regulated, observed or taxed by the government, but are not illegal (Spring, 2009). The informal sector has been viewed as a marginal and transitory phenomenon that inevitably would be absorbed by the modernising urban industrial sector (Brown & McGranahan, 2016).

Yet, despite huge economic growth in the world, the informal undertakings continue to mushroom in all developing countries (Schneider, 2002) and informal business activities have become a significant and durable feature of Africa’s economic landscape. Indeed, Africa has more informal workers than anywhere else in the world: they account for around 80% of the workforce (Williams, 2014). Tanzania’s informal sector grew from 10% of the official GDP during the late 1960s, to 20% after the mid-1980s and to around 58.3% in 1999 and 2000 (Bagachwa & Naho, 1995; Schneider, 2002). These figures suggest that the informal sector in poor countries is growing and is here to stay. The most visible type of informal economy is street trade.

Street traders sell products in the street without having a permanent built-up structure (Bhowmik, 2005). Street traders are also referred to as street vendors, hawkers, peddlers, roadside sellers or petty traders. Street trade accounts for around 43% of all informal non-agricultural employment in Sub-Saharan Africa (SSA) (Roever & Skinner, 2016). In Dar es Salaam, which is the economic hub of Tanzania, around 25% of the population were estimated to conduct street trade in 2007 (Lyons & Msoka, 2010). The rapid growth of street trade is attributed to urbanisation, globalisation, liberalisation and the fall in formal production in developing countries (Lyons & Msoka, 2010). The academic interest in street trade arises from the fact that street trading is important for the lives of the poor, but street traders are constrained by weak business skills, financial problems, legal problems, and poor working environments.

Street trade is the most visible type of informal economy in Dar es Salaam Tanzania. Street trade serves as a key livelihood opportunity for poor, less educated, migrant from rural, and women for whom formal employment is unattainable. The motives behind street trade are low entry barriers, which include little legal requirements, initial capital, education, or need to pay rent (Chen, 2007). Street traders sell
various consumer goods from electronics, foods, soft drinks, cosmetics, clothes, cigarettes, snacks, vegetables, fish, fruits, to herbal medicines. For many years street trade was illegal in Tanzania. However, from May, 2018 Tanzania Revenue Authority started to provide identity cards to street traders, a step toward formalization (TRA, 2018). Unlike other countries where street traders’ markets mainly target lower and middle income populations, in Tanzania street traders sells to all income levels including high income earners and government officials. In Tanzania, street traders market their products in roads (traffic congestion), bars, near market place, churches, schools, hospitals, and any other congested places. Street traders earn little profit. However, street trade continues to be a ‘shock absorber’ for many including the poor, women, and less educated people in developing countries (Lyons & Msoka, 2007).

Several research studies have been conducted on the informal sector and street trade. There are studies about socio-cultural characteristics (Asiedu & Agyei-Mensah, 2008; Mitullah, 2003), challenges (Onodugo, Ezeadichie, & Onwuneme, 2016), inclusion in urban planning (Mitullah, 2003; Brown, Lyons, & Dankoco, 2010; Bromley, 2000), legal aspects (Vargas-Falla, 2016; Jonga, 2012; Lyons, 2013), contribution to the economy (Chen, 2007; Donovan, 2008; Lyons, Brown, & Msoka, 2014), poverty reduction (Kamunyori, 2007), informality (Lyons, 2013), and political influence (Kamunyori, 2007). Despite the large amount of research on street trading, there is a limited number of research on interventions to improve street trade. The existing literature on Information and Communication Technology (ICT) for the informal economy (Garcia-Murillo & Velez-Ospina, 2017; Opiyo & Owiti, 2006; Deen-Swarray, Mpho, & Christoph, 2013) has shown technology’s potential to transform the informal sector. However, while several initiatives target small-scale farmers (Misaki, Apiola, & Gaiani, 2015; GSMA, 2017b), healthcare (GSMA, 2017c), and education (Bidwell, et al., 2014; Eneza, 2016; Jantjies & Joy, 2015), just to name a few examples, not many initiatives to improve street traders’ business exist. Thus, there is a lack of meaningful ICT projects that targets informal street traders in developing countries.

The use of ICT, specifically mobile phones, has increased radically in African countries. For example, voice call subscriptions in Tanzania have increased from 1% of the population (284,109 subscribers) in 2000, to 80% of the population (40,173,783 subscribers) in 2016 (TCRA, 2017). The mobile revolution has brought new opportunities to transform the socio-economic activities of Africans by reducing transaction and production costs, increasing communication, increasing financial inclusion and bridging the digital divide. As adoption of mobile phones increases, it becomes important to research how to grasp technological opportunities to overcome African socio-economic challenges. This is important, because ‘access to ICTs do [sic] not guarantee development, what matters are actions once access is provided’ (Alampay, 2006). Many African micro, small and medium enterprises have not yet substantially benefitted from ICT, which has been mostly used for communication purposes, and
not for deeper forms of information processing and management (Murphy, Carmody, & Surborg, 2014). Smartphone ownership is increasing in many developing countries. This will bring new technological opportunities as compared to the currently available Unstructured Supplementary Service Data (USSD)\(^1\) platforms in Africa.

The technological revolution has brought many change processes to Africa. Mobile money, for example, has revolutionised payments in Africa and brought access to credit for those who cannot access formal banking. On the other hand, while high hopes are often tied to technology initiatives, a great number of projects have failed. For example, educational technology has not yet delivered the high hopes assigned to it. One common reason for failure is a poor understanding of the context of implementation (Heeks, 2002). In addition, there are several mobile apps for the informal workers in Africa, which remain with little number of users, despite of their potential for growth and development. Little adoption of mobile apps particularly to the informal workers are attributed by many factors as explained by technology adoption and reasoned action models (Fishbein & Ajzen, 2010; Davis, 1989; Venkatesh, Morris, & Davis, 2003). These models introduce factors that can affect the user acceptance of technology. In this thesis, factors like ease to use, embedded benefits, participatory design, and performance expectancy are considered to increase the possibility of adoption and usage.

To improve the performance of street trade, this thesis focuses on exploring daily business activities and strategies of street traders, finding mobile applications, which are contextualized to street trade ecology, design and develop mobile application to overcome street traders’ record keeping challenges, and evaluate how the designed bookkeeping application differs from other ICT application for the informal workers. It has become clear that technology projects need to be equipped with research in order to understand what to implement, what the best ways are to implement and to carefully evaluate the impact. The need to design mobile application is motivated by the fact that, although there are several good stories about the positive impact of mobile phones to the life of the poor, there are only few mobile interventions targeted to street traders. Mobile phones are ideal technology to street traders because they are increasingly accessible and affordable to them. The price of the mobile phones is relatively cheaper when compared with other ICT hardware like computers. For these purposes, Design Science Research (DSR) (Johannesson & Perjons, 2014) provides a good framework.

In recent years, DSR has emerged as a vital research approach in the field of information technology. The DSR paradigm has its roots and history in the sciences and engineering of the artificial (Hevner & Chatterjee, 2004). DSR is the scientific

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\(^1\) Unstructured Supplementary Service Data (USSD) is a global system for mobile (GSM) communication technology that is used to send text between a mobile phone and an application program in the network. [https://en.wikipedia.org/wiki/Unstructured_Supplementary_Service_Data](https://en.wikipedia.org/wiki/Unstructured_Supplementary_Service_Data)
study and creation of artefacts as they are developed and used by people with the
goal of solving practical problems of general interest (Johannesson & Perjons, 2014).
The artefacts of DSR can be either constructs, models, methods, instantiations, social
innovations, new techniques or information resources (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008; Hevner & Chatterjee, 2004). DSR is an important
method because it guides the designers to construct useful artifacts to solve problems
(Peffers, et al. 2008). It is commonly used to resolve an unsolved problem or invent
something new that adds value to the society. The current thesis used design science
approach to come up with a mobile solution to street traders’ bookkeeping chal-

This is an article-based thesis, which uses DSR. This thesis is combined from four
articles, denoted as PI, PII, PIII and PIV, and the present introduction. This research
evolved in phases. First, the problems of Tanzanian street traders were researched
and explicatied in PI and PII in order to understand what to design. Second, based on
the findings of PI, requirements for a technology artefact were defined, and a solution
for street traders’ bookkeeping was designed and developed in PIII. Third, in order
to evaluate, position and compare the project among other similar initiatives, a tech-
ology review was conducted in PIV.

1.2 RESEARCH QUESTIONS

The research questions addressed in this thesis were as follows.

Paper one (PI)

- RQ1 (PI): *What skills and strategies do street vendors need to succeed in their business environment?*
- RQ2 (PI): *What are the street vendors’ perceptions on how to improve their success in street vending?*

Answering the abovementioned research questions was necessary in order to gain a
picture of the street traders’ daily business life, especially from the viewpoint of mar-
keting, record keeping, management, and strategies, as well as the street traders’ per-
ceptions of improvements. The research design of PI was qualitative.

Paper two (PII)

Based on the findings from PI, another research study about street traders’ daily busi-
ness challenges and related technology innovation opportunities was conducted. The
research questions of PII were:
• RQ1 (PII): What are the entrepreneurial needs, strengths, limitations, and types of work undertaken by street traders in Dar es Salaam?
• RQ2 (PII): What technology innovation possibilities arise from the entrepreneurial needs, strengths, limitations, and types of work undertaken by street traders in Dar es Salaam?

The research design of PII was quantitative. Together, the findings from PI and PII were used as the basis for building a contextualised technology artefact targeted for street traders.

Paper three (PIII)

• RQ1 (PIII): How can an intercultural team co-create a bookkeeping application that is contextualised for Tanzanian street traders by following the principles of design science research?

In PIII, the investigation sought to understand how a team of designers and researchers from different cultural backgrounds could team up to design and develop a mobile application that is contextualised for the needs of Tanzanian street traders.

Paper four (PIV)

• RQ1 (PIV): What are the ICT projects designed for Sub-Saharan Africa (SSA) informal workers?
• RQ2 (PIV): What challenges of the informal workers do these ICT projects solve?

The purpose of RQ1 in PIV is to understand the technologies designed so far to address the informal workers’ challenges in SSA. The purpose of PIV.RQ2 is to get to know the challenges addressed by the available ICT projects in SSA. The findings of this research contribute to the evaluation requirements of DSR.

1.3 THESIS STRUCTURE

This thesis is organised per the stages of DSR. First, research methods used are explained in Chapter 2. This is followed by problem explication (Chapter 3), requirement definition (Chapter 4), design and development and demonstration (Chapter 5), and evaluation (Chapter 6). Finally, the thesis concludes with a discussion and conclusions (Chapter 7).
1.4 DEFINITIONS OF KEY CONCEPTS

Street traders—Street trade means informal business activities involving the production and exchange of products, without having a permanent business location, business permit, violation of zoning codes, non-payment of tax, and absence of labour regulations (Cross, 2000; Wongtada, 2013). Street traders may be stationary in the sense that they occupy space on the pavement, public or private space, or they may be mobile, moving from one point to another carrying their products on bicycles, baskets, shoulders, or hands (Bhowmik, 2005). Street trade is sometimes referred to as street vending, yet in the current research, they mean the same thing.

Informal economy—Informal economy is described as an unorganised sector, unregistered economy, third economy, parallel economy, shadow economy, and so forth. Activities of the informal economy are not registered, regulated, observed, or taxed by the government, but are not illegal (Spring, 2009). The common informal economic activities are street trading, small-scale manufacturing (welding, carpentry, tailoring), smallholder farming, motorcycle driving services, and micro businesses. The informal economy also includes various service providers, such as barbers, cobblers, butchers, masons, home and farm workers, musicians, artisans, and small-scale miners. They often work from small kiosks or stalls, workshops, and garages. In this research, the term informal economy and informal workers are used interchangeably. Informal workers are those workers in the informal sector.

Bookkeeping—Bookkeeping means a systematic recording of business transactions in the books of accounts (Thukaram, 2007). Properly recorded bookkeeping allows small businesses to keep accurate information about their business as well as to make wise business decisions. In this thesis, bookkeeping is referred to as a process of recording street traders’ business information, including sales, purchases, stocks, and business expenses in proper books of accounts.

Mobile technology—Mobile technology and mobile computing describe computing devices, including software, hardware, and communications with a characteristic of mobility (Hameed, 2003). The popular mobile devices are mobile phones, palmtops, laptops, personal digital assistants, pocket PCs, and smartwatches. The current research used smartphones as a platform to develop a mobile bookkeeping application for Tanzanian street traders.

Design science research—In recent years, design science research (DSR) has emerged as a vital research approach in the field of information and communication technology. DSR is the scientific study and creation of artefacts as they are developed and
used by people, with the goal of solving practical problems of general interest (Johannesson & Perjons, 2014). The goal of DSR is to produce artefacts that can address life business challenges (Hevner & Chatterjee, 2004). The artefacts of DSR can be either constructs, modes, methods, models, instantiations, social innovations, new techniques or information resources (Hevner, March, Park, & Ram, 2004). According to Johannesson & Perjons (2014) an artefact is created to address a practical problem. A practical problem is a gap between the current state and a desirable state, as perceived by the participants in a practice. Design science research also contributes to the contextual knowledge about the artefacts. This thesis used DSR to come up with a technology solution for street traders.

**Artefact**—An artefact is an object made by humans with the intention to be used for addressing a practical problem (Johannesson & Perjons, 2014). Information technology artefacts can be constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems) (Gregor & Hevner, 2013). In this thesis, the term artefact is used to refer to products that have or can be converted into a material existence as an artificially made thing. Generally, many ICT artefacts have some degree of abstraction but can be easily transformed to actual material (Gregor & Hevner, 2013).
2 METHODS: DESIGN SCIENCE RESEARCH

This chapter discusses the design science research as applied in the project.

2.1 INTRODUCTION

This thesis is a design science research (DSR) project. DSR studies the development of solutions for practical problems arising from real-life situations (Hevner & Chatterjee, 2004). DSR projects are typically divided into the phases of ‘problem explication, requirement definition, design and development, demonstration, and evaluation’. The phases can be iterative. DSR projects ‘do not only create artefacts but they also answer questions about artefacts and their environment’. In comparison to plain design, DSR projects typically use a combination of research methods in a project’s different stages (Johannesson & Perjons, 2014, p. 77).

There are various design science research frameworks as summarized by (Peffers, et al., 2006). These frameworks differ in number of stages and the names used however; all aim at producing artefacts that have utility to solve real world problems. The common elements repeated in different DSR frameworks are problem definition, design and development, and evaluation (Peffers, et al., 2006). This thesis adopted (Johannesson and Perjons, 2014) framework to design and develop mobile application for street traders’ bookkeeping. Unlike other frameworks, Johannesson and Perjons (2014) include related activities in each phase with well documented inputs needed and the expected output. Also, the (Johannesson and Perjons, 2014) framework explains the research strategies and methods in each activity of DSR. In addition, Johannesson and Perjons (2014) show the guidelines of how to relate research to an existing knowledge base. Lastly (Johannesson and Perjons, 2014) framework offers illustrations and examples for each required process, which makes it straightforward to understand and follow.
Over the past decade, DSR has re-emerged as an important research paradigm in the field of information systems. The DSR approach has a long tradition in developed countries, but is not very common in developing countries (Winter, 2008). There are many design science researchers in the Nordic countries, Netherlands, Italy, France and the United States, just to mention a few (Winter, 2008). However, DSR is a relatively new paradigm in computing, and little is known about its uptake in Africa (Naidoo, Gerber, & van der Merwe, 2012). The current thesis employs DSR to address the challenges of street traders in Tanzania. The goal of ICT for Development (ICT4D) research is to innovate or design something new to address a wide range of challenges (Islam & Grönlund, 2011). DSR helps to guide the systematic design and associates various design aspects to artefact development.

In problem explication and requirement definition, both qualitative and quantitative methods as well as action research and case studies are typically used. Typically, in design and development, and demonstration, research methods are less important, ‘while creative methods such as brainstorming, participatory design or agile software processes are used’ (Johannesson & Perjons, 2014, p. 79). In evaluation, controlled experiments may be used, but case studies and action research are also common. The combination of methods in different stages depends on the case at hand and typically
differs from project to project (Johannesson & Perjons, 2014). Figure 1 shows the methodology used in the current DSR project.

DSR projects may focus specifically on some of the phases, while other phases are treated more lightly (Johannesson & Perjons, 2014). A common type of DSR project is ‘problem-focused design science research’ (Johannesson & Perjons, 2014, p. 79), where the focus is specifically on problem explication, and detailed investigations are carried out in the requirement definition stage. Another common type of DSR is development and ‘evaluation-focused design science research’, which starts from existing requirement specifications and focuses only on software development methods. This research project, reported in this thesis, is a ‘problem-focused design science research’ project (Johannesson & Perjons, 2014, p. 79).

Table 1 summarises DSR activities in this research. The problem was explicated through a literature review and qualitative research on daily activities and strategies of street traders in Dar es Salaam. The requirement definition was done through an idea generation workshop and research on existing ICT applications for informal workers. Street traders’ requirements were used to design and develop a mobile application for bookkeeping through a participatory approach. The artefact was evaluated based on implementation principles and comparison with the existing related solutions. Chapters 3–6 discuss each of these steps.

2.2 PHILOSOPHICAL ASSUMPTIONS

Academic research is always based on a set of beliefs and philosophical assumptions. The common philosophical assumptions are often categorized to post positivism, constructivism, transformative, and pragmatism (Creswell, 2014). This thesis is characterized with different philosophical stances. It has elements from constructivist, pragmatist, and post positivist traditions. Constructivism, social constructivism, and interpretivism are typically seen as approaches to qualitative research (Creswell, 2014). The researchers’ intention in constructivism is to make sense of (or interpret) the meanings others have about their settings (Creswell, 2014). The first aim of the current thesis was to understand the activities, strategies, and skills of street traders, to plan for ICT interventions. The respondents had an opportunity to tell stories about their daily business activities and challenges. Some of the questions were open-ended hence allowing respondents to tell a broad range of information. Researchers recorded everything spoken by street traders, took some pictures, and observed the business activities done by street traders, then decoded and analyzed the data.

Another position about worldviews comes from the pragmatists philosophy. Pragmatists hold on applications—what works—and solutions to the problems (Patton 1990). Mixed methods researchers and theorists are strongly associated with pragmatism’s worldview. The role of a pragmatic researcher/designer is an actor,
participant, and an agent of change. Pragmatism is considered an appropriate paradigm for action research and design research. In addition, the nature of research is not a single discrete event but a process consisting of several phases with individual tasks and problems (Creswell, 2014). The research is action oriented, practical, aiming at understanding, improving the situation, contextualized to real world challenges and understanding that the problem in hand is more important than methods (Goldkuhl, 2012). The goal of the current thesis is to find solutions to street traders’ business weaknesses through technology. The research started with constructivism to understand the working environment of street traders. Then it employed sequential mixed research method (Creswell, 2014) to better understand the business supply chain of street traders, then design and develop a mobile bookkeeping application for and with street traders. The research cycle ended with a development of a contextualized solution to street traders. It employed various data collection methods e.g. personal interview, survey, focus group discussion, workshops, and meetings with intended solution users to increase the validity of the solution made.

Postpositivist (and positivist) worldview reflects a deterministic philosophy in which causes probably determine effects or outcomes (Creswell, 2014). The common form of Postpositivist research is the correlational design in which investigators use the correlational statistic to describe and measure the degree or association (or relationship) between two or more variables or sets of scores (Creswell, 2014). In the current thesis, correlation analysis was used to look at the relationship between street traders’ working hours and daily profit. However, basing on the nature of thesis (design science) little elements of positivist can be located.
Table 1 Summary of DSR activities in this thesis.

<table>
<thead>
<tr>
<th>DSR Stage</th>
<th>Description</th>
<th>Methods used</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem explication</strong></td>
<td>Review of literature on street vending Qualitative research about day-to-day challenges of street vendors in Dar es Salaam (PI), followed by quantitative research on technology innovation opportunities (PII)</td>
<td>Literature search Mixed methods (sequential qualitative &amp; quantitative research design)</td>
</tr>
<tr>
<td><strong>Requirement definition</strong></td>
<td>Idea generation workshop (PII) Workshops listed in Design Science Research in Information Systems and Technology (DESRISt) article Defining requirements for a bookkeeping application (PIII) Look at research on existing applications that could potentially solve the problem</td>
<td>Brainstorming Participatory design Participatory design Literature search</td>
</tr>
<tr>
<td><strong>Design &amp; Development, and Demonstration</strong></td>
<td>Idea generation workshop (PII) Co-creating a bookkeeping application that is contextualised for the needs of Tanzanian street vendors (PIII) Icon Design Application Development</td>
<td>Brainstorming Participatory design Participatory design Android Programming</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>Evaluating the prototype by case study and observation (PIII) Relating to a knowledge base by reviewing literature on similar mobile for development (M4D) projects (PIV)</td>
<td>Case study, Observation Literature review</td>
</tr>
</tbody>
</table>

2.3 INTERCULTURAL CO-DESIGN

Successful participatory intervention in the development of Information Systems in Africa has been hindered by cross-cultural matters (Winschiers, 2006). The politics of design, the nature of participation, and the methods, tools and techniques for carrying out design projects are affected with the social-cultural environment of the recipients (Puri, Byrne, Nhampossa, & Quraishi, 2004). During the design process, a designer needs to consider how culture affects the ways in which people view, adopt and use technology (Kamppuri, 2011). This thesis presents an intercultural co-design project, where a researcher (Tanzanian), software developer (Finnish) and street trad-
ers (Tanzanian) team up to design and develop a mobile application for street traders’ bookkeeping. The motive behind intercultural co-design is the fact that, Tanzania has many social economic challenges that can be solved by information technology, however, Tanzania lacks technical experts who can do it. Many lessons can be drawn from this team.

Firstly, an intercultural team increases the sense of ownership. When participants see someone of their culture in the project, then they feel the ownership (part and parcel). This is important because it eliminates the notion of top-down centric approaches, where projects are designed in western countries and being positioned in Africa. Then, intercultural team is important because it eliminates the language barrier. The street traders who participated in this project communicate only in Swahili, therefore the researcher acted as a bridge to connect the group. The intercultural co-design in this project brought together various experiences, and knowledge from a developed country (Finland), developing country (Tanzania), from the academic world, as well as from street life. Also, this project shows that it is possible to mitigate the challenges of marginalized like street traders even through little resources and a short period. One challenge observed in this project was insufficient time to observe how street traders will continue to use the application after the test period. Intercultural co-design also provides a unique learning experience to all project participants.

2.4 CONCLUSION TO DSR

This chapter is about the method applied in this thesis. The current thesis employed a DSR paradigm to understand the business life of the street traders and develop an ICT solution relevant to their problems. The project started by reviewing various literature for street trade in developing countries to understand their daily life and activities. The literature review motivated the qualitative PI to explicate the problem. The requirement definition was done in PII and PIII. The working application for street traders’ bookkeeping was designed, developed, and demonstrated in PIII. Evaluation was done in PIII and PIV. Each of the steps of DSR are discussed in the following chapters.
3 PROBLEM EXPLICATION

3.1 CHAPTER INTRODUCTION

In design science research, problem explication consists of three main sub-activities: ‘making the problem definition as precise as possible, positioning, and justifying the problem, and finding its root causes’ (Johannesson & Perjons, 2014, p.91–102). This chapter follows the guidelines and suggestions of Johannesson and Perjons (2014, pp. 91–102) and is based on papers PI and PII of this thesis.

The phenomenon of informal street trading is complex, multifaceted, and highly dependent on context (Wongtada, 2013). Street trading in Dar es Salaam, Tanzania may differ quite a lot if compared to street trading in another place. For example, street traders in Cameroon pay sanitary fees, inspection tax, market fees, and other taxes (Fonchingong, 2005), while their counterparts in Tanzania do not. Much of the available research on street trading focuses on challenges, social, and economic factors, informality, and legality (Wongtada, 2013). Very little previous research exists on interventions designed to support informal street traders. For these reasons, it is not a straightforward task to figure out what kind of intervention would potentially improve street traders’ business prospects.

To identify challenges facing street traders’ daily business activities, that can be addressed with technology, it was necessary to conduct a research (PI). Thus, for the purposes of problem explication, a mixed methods research strategy (Creswell, 2014) was conducted to understand the daily business of street traders in Dar es Salaam, Tanzania. An exploratory sequential mixed methods approach was employed, where qualitative research was followed by quantitative research (Creswell, 2014).

This chapter is organised as follows. First, an overview of what research shows about street trading is presented (Section 3.2). Second, an overview of the conducted qualitative research (Section 3.3) is given, followed by the results of the quantitative study (Section 3.4). Finally, Section 3.5 answers the recommendations for problem explication laid out by Johannesson and Perjons (2014, p. 91–102), which are: ‘problem definition, justification of problem, and root cause analysis’.

3.2 RESEARCH ON STREET TRADING

Street trade has grown to become the lifeblood of African cities; it is among the largest sub-group in the informal sector (Brown, Lyons, & Dankoco, 2010). In many developing countries, lack of agricultural productivity in rural areas, unemployment in urban areas, lack of formal employment, low education and poverty have pushed people out of their villages into the cities in search of a better existence (Goldsmith,
Many of these migrants are youth and women, who possess low levels of education and capital, and hence find it difficult to get formal employment or start their own business (Onodugo, Ezeadichie, & Onwuneme, 2016). In many cases, the only opportunity available is to engage in the informal sector. The most common form of informal employment in many developing countries is street trade (Roever & Skinner, 2016). Street traders operate on the street without having a permanent built-up structure (Wongtada, 2013).

Figure 2 shows a street trader in Dar es Salaam, who displays products in an unauthorised business location. In Tanzania, it is common to see street traders displaying products in unofficial places like bridges, un-used motor vehicles, trees, walls, fuel station, gardens, etc. hence make their business at risk.

Street traders can be stationary or mobile; stationary in the sense that they occupy space on the pavements or other public or private spaces, or they may move from one place to another while carrying their wares on pushcarts or in baskets on their heads (Bhowmik, 2005). Street traders are commonly referred to as hawkers, peddlers, street vendors or micro-traders (Lyon & Msoka, 2007). In Tanzania, the Kiswahili word for street trader is machinga.
Street traders are found in all major cities of developing countries, particularly poor countries. Street traders sell different products including food items, ornaments, fruits, vegetables, clothes, stationeries, cosmetics, herbal medications, soft drinks and various other things. Most street traders locate themselves in strategic, easily seen spots that attract heavy human and vehicular traffic (Asiedu & Agyei-Mensah, 2008). They can be found near highways, bus stands, mosques, churches, railway stations, marketplaces, schools, colleges, hospitals, and in public gathering places.

3.2.1 Research Perspectives
There is a relatively large amount of research on street trade in Africa. These include Sarpong and Nabubie (2015), Wongtada (2013), Amoah-Mensah (2016), Meneses-Reyes and Caballero-Juárez (2014), Lyons (2013), and Lyons and Msoka (2010), to mention a few. Most of these studies focused on the challenges of the street traders, and ignored other areas, e.g. improving street trade business activities. In many African countries street traders are perceived as problematic and parasitic to the urban economy (Inge Nesvag, 2000), a nuisance, a failure in society and lacking knowledge (Sarpong & Nabubie, 2015) and promoting underground activity that undermines the healthy function of the formal economy (Mitullah, 2003). The studies explained various factors that constrain street trade, these include: difficult to access finance (Lyons, 2013), marginalisation, unpeaceful behaviour, harassment, assault, and seizure of products (Kamunyori, 2007; Asiedu & Agyei-Mensah, 2008), poor political perceptions (Kayuni & Tambulasi, 2009; Tonda & Thembela, 2016), evictions (Tonda & Thembela, 2016; Onodugo, Ezeadichie, & Onwuneme, 2016), poor working environment (Lyons & Msoka, 2010), exclusion from national policies and strategies (Lyons, Brown, & Msoka, 2014; Rogerson, 2016), illegality (Jonga, 2012; Vargas-Falla, 2016), and weak trade association (Brown, Lyons, & Dankoco, 2010; Mitullah, 2003).

Despite these challenges, street trade continues to serve as a main source of employment and income for the poor and less educated across the world, particularly in Africa (Chen, 2007). Millions of people in Africa make a living through selling goods on the streets. Street trade is an important source of employment, income, and low-priced goods (Mitullah, 2003), it creates a social life (Kayuni & Tambulasi, 2009), and acts as a social safety net in an undeveloped welfare system (Donovan, 2008). Street traders’ income is often used to support family, dependents, pay school fees, and pay medical expenses (Lyons, Brown, & Msoka, 2014).

Based on the challenges facing street trade in Africa, some recommendations have been made, including: legalisation (Vargas-Falla, 2016), reducing nuisance factors (Sarpong & Nabubie, 2015), inclusion in ongoing economic reforms (Lyons, 2013), and creating a conducive working environment (Marianne, 2015). Brown, Lyons, and
Dankoco (2010) recommend strengthening both the formal and informal street traders’ associations, increasing legal recognition of the rights of street traders, and providing a platform for inclusion in the space of influence.

Very limited research can be found that addresses the skills, activities, and the improvement of street trade. Little research has been done in relation to skills level and skills development. With an absence of research to explore how street traders carry out their business in relation to skills applied, it is difficult to impose interventions. Again, many researchers have proved the power of ICT to empower the informal sector (Opiyo & Owiti, 2006; Deen-Swarray, Mpho, & Christoph, 2013; Garcia-Murillo & Velez-Ospina, 2017), however there are few ICT projects to improve the informal sector. This thesis explored street traders’ skills, strategies, and their activities to find out their level of business skills and propose a meaningful technology intervention. A summary of the major findings of the existing literature about street trade is presented in Table 2. The summary was extracted from various research reports carried in Africa.

Table 2. Major findings of the existing literature on street vending in Africa.

<table>
<thead>
<tr>
<th>Major findings</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Findings about street traders’ challenges</strong></td>
<td></td>
</tr>
<tr>
<td>Informality and lack of collaterals affect street traders’ access to credit</td>
<td>(Lyons, 2013)</td>
</tr>
<tr>
<td>In many countries street trade is illegal in terms of commercial laws and business location</td>
<td>(Jonga, 2012; Vargas-Falla, 2016; Lyons, 2013)</td>
</tr>
<tr>
<td>Street traders face many difficulties including eviction, marginalisation, unpeaceful behaviour, harassment, assault and seizure of products</td>
<td>(Kamunyori, 2007; Asiedu &amp; Agyei-Mensah, 2008; Skinner, 2008)</td>
</tr>
<tr>
<td>Perceived negatively by formal business owners, public local authorities and politicians</td>
<td>(Kayuni &amp; Tambulasi, 2009; Tonda &amp; Thembela, 2016)</td>
</tr>
<tr>
<td>Excluded from important national policies and strategies, e.g., MKURABITA in Tanzania</td>
<td>(Lyons, Brown, &amp; Msoka, 2014; Rogerson, 2016; Lyons, 2013)</td>
</tr>
<tr>
<td>Weak trade associations</td>
<td>(Brown, Lyons, &amp; Dankoco, 2010; Mitullah, 2003)</td>
</tr>
<tr>
<td><strong>Findings about the importance of street trade</strong></td>
<td></td>
</tr>
<tr>
<td>Source of employment, and income to poor and less educated, safety net income</td>
<td>(Kayuni &amp; Tambulasi, 2009; Donovan, 2008; Lyons, Brown, &amp; Msoka, 2014; Chen, 2007)</td>
</tr>
<tr>
<td><strong>Findings about how to improve street trade</strong></td>
<td></td>
</tr>
<tr>
<td>Need for legalisation</td>
<td>(Lyons, 2013)</td>
</tr>
<tr>
<td>Involvement of private sector</td>
<td>(Marianne, 2015)</td>
</tr>
<tr>
<td>Strong trade association</td>
<td>(Brown, Lyons, &amp; Dankoco, 2010)</td>
</tr>
<tr>
<td>Call for consultation rather than confrontation in dealing with street traders</td>
<td>(Asiedu &amp; Agyei-Mensah, 2008)</td>
</tr>
<tr>
<td>Street vendors devise more subtle forms of resistance instead of confrontation with armed police</td>
<td>(Musoni, 2010)</td>
</tr>
<tr>
<td><strong>Findings about street traders’ strategies</strong></td>
<td></td>
</tr>
<tr>
<td>Cost reduction strategies to remain competitive (networking, undifferentiated marketing, sell convenient products and change of products)</td>
<td>(Amoah-Mensah, 2016)</td>
</tr>
</tbody>
</table>
### 3.3 QUALITATIVE RESEARCH (PI)

This section is about qualitative research (PI). The informants were 39 street traders. Data was collected in Dar es Salaam, Tanzania from September to December 2014.

To be able to consider potential technology interventions, it was essential to research the daily business activities of street traders in Dar es Salaam to understand the problem in depth and find niches for technology interventions. Thus, a qualitative approach was employed. Qualitative research is important in information system research; it is used to develop a deep understanding of issues and inductively generate new theoretical insights (Venkatesh, Brown, & Bala, 2013). The interview was conducted with 20 street traders to understand their business activities, business skills, and the needed skills to improve their business. After the interview, the focus group discussion was carried with 4 groups. First group had 5 women, the second 4 women, third had 5 men, and the fourth had 5 men. The total informants were 39 street traders from different parts of Dar es Salaam, who were between 18–35 years of age, who had more than one year of business experience and who sold legal products. Thematic semi-structured interviews and focus group discussions were conducted. Interviews were recorded, transcribed and translated from Kiswahili to English for data analysis. The data was analysed by using qualitative content analysis (Denscombe, 2010, p. 281). Appropriate parts of the texts were selected, the text was broken down into small meaningful sets, categories for data analysis were prepared, coded, the occurrence of frequency established, and analysed based on magnitude of the occurrence, and the explanation of the result was given.

In this research, the daily business activities of street traders in Dar es Salaam were studied. The research targeted the skills and strategies that are necessary for street traders to conduct their business and their perceptions about how to improve their success. Street trading shares the same basic goal as other businesses, which is to generate profit. Thus, the research was approached from the common business domains of marketing, bookkeeping, entrepreneurship, and business management, which were selected as the themes for the qualitative research. The summary of the participants in qualitative research are shown in Table 3. Therefore, this research explored the challenges of street traders from these four business viewpoints.

| **Table 3. Demographic profile of participants in Qualitative research.** |
|--------------------------------|---------------------------------|---------------------------------|
| **Category**                          | **Interview**                                      | **Focus Group discussion**                          |
| Number of Participants                  | 20                                              | 19                                             |
| Sex                                    | 16 male & 4 Female                             | 10 male & 9 female                            |
| Age (years)                            | 18-35                                           | 18-35                                          |
| Products sold                          | Fruits, clothes, shoes, arts, bags, electronics, stationaries | Fruits, clothes, shoes, arts                                      |
| Location                               | Dar es Salaam Tanzania                         |                                                |
| Respondents                            | Mobile street traders                           |                                                |
3.3.1 Overview Results of PI

The results opened the business activities of street traders from multiple viewpoints. A wide variety of issues was covered on a descriptive level. These issues included gender issues, business profile, product obtaining actions, product price setting actions, selling route selection, promotion of products, record keeping, prospects, and risk behaviour activity. The trading day starts when products are obtained from wholesalers or formal shops, they are then marketed and sold, and while doing this, a variety of managerial and strategic decisions in relation to route selection, risk prevention, pricing, promotion, money handling, and planning should be made. Regarding marketing, bookkeeping, entrepreneurship, and management, the following was found.

From a marketing viewpoint, it was found that street traders do not have the skills or means to do much marketing. When obtaining products, there is no possibility to make very informed decisions regarding competition, profitability, product quality, or origin of products, because such information and data is not available. Also, it was found that street traders operate mostly within a one day operational cycle; it is not possible for them to expand their business, but they buy and sell products in small quantities. Moreover, the pricing policies are tacit, and do not account for issues such as expenses, returns or competition. The prices do not necessarily reflect actual business costs, and hence the traders are not aware of how optimal their business operations are, but the activities are based on previous experiences, intuition and randomness. The final selling price is reached via negotiation. Figure 3 shows a street trader negotiating the price with a customer in Dar es Salaam, Tanzania. The findings of PI show that some of the customers do not buy from street traders because they do not like to engage in price negotiation.
Regarding bookkeeping, the interviewed street traders did not record any business transactions at all. The interviewees also explained that if anything is recorded in books, it is done in an unsystematic manner. Thus, all data on daily activities, sales, expenses, profits, cash, and stock are missed, which creates another constraint for the traders. The major reasons for the lack of record keeping was explained to be a lack of skills and lack of perceived benefit.

From a management perspective, it was shown that street traders do not have daily, weekly or monthly plans, such as selling targets, hence it is difficult for them to evaluate business performance very well. Regarding business strategies, the interviewed street traders did not report having well-thought-out strategies, for example persuading someone to buy or make a repeat purchase. The sources of supply, types of products, pricing, promotion, and after-sales customer care are based on tacit knowledge and intuition, rather than strategic plans. Risk prevention, such as running away from theft, bribe paying or optimising stock location, and amount, brings a lot of decision making into the daily operations. Skill development, training, and
education were considered by the traders as interesting options in regard to future interventions. The main results from the qualitative research are shown in Table 4.

Table 4. Summary of results in qualitative research.

<table>
<thead>
<tr>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender issues</td>
<td>Street trade is dominated by males</td>
</tr>
<tr>
<td>Business profile</td>
<td>Initial investment ranges from 14.45€ to 1445€, daily profit ranges from 2.5€ and 20€, typical business hours from 6AM to 9PM</td>
</tr>
<tr>
<td>Marketing</td>
<td>Obtaining products -Main sources of products are 1) wholesalers 2) Mali Kauli(^2) and formal shops, restocking behaviour is common</td>
</tr>
<tr>
<td></td>
<td>Setting product price -Instinct-based pricing, bargaining culture, customer profiling based on outlook</td>
</tr>
<tr>
<td></td>
<td>Route selection -Typical routes, estimates of customer movement, estimates of police movement, estimates of traffic</td>
</tr>
<tr>
<td></td>
<td>Popular places: traffic jams, office places, bus stands</td>
</tr>
<tr>
<td></td>
<td>Promotion of products- No systematic way of connecting with customers</td>
</tr>
<tr>
<td></td>
<td>Simple promotion models, collaboration between traders</td>
</tr>
<tr>
<td>Bookkeeping</td>
<td>No record keeping: no perceived benefit, no skills</td>
</tr>
<tr>
<td></td>
<td>No access to capital, unsafe money handling</td>
</tr>
<tr>
<td>Prospects</td>
<td>Hopes to upgrade to formal business, hope of education</td>
</tr>
<tr>
<td>Risk prevention</td>
<td>Risk of products confiscated by police</td>
</tr>
<tr>
<td></td>
<td>Risk of theft, risk of weather ruining products</td>
</tr>
<tr>
<td></td>
<td>Risk minimisation strategies: stashing, alerting, escaping, grouping</td>
</tr>
<tr>
<td>Management</td>
<td>No plans, no targets, no competitive business strategies, lack of business strategies</td>
</tr>
</tbody>
</table>

3.3.2 Conclusions of PI

After a qualitative research (PI), the quantitative research was used to gain additional insights on the findings. Some of the issues revealed in PI needed to expand and elaborated by conducting surveys from the wide geographical areas with more respondents (Venkatesh, Brown, & Bala, 2013). In addition, the quantitative study was conducted to confirm the findings from a qualitative study, which was conducted with small samples of street traders from Dar es Salaam central business district. Research of PI provided a wide overall picture of different things that affect the daily business of street traders, but it has not provided a very comprehensive or deep understanding about any of the issues. In the future, several tracks of research could alleviate this weakness. For example, the flow of different products could be investigated to build a more comprehensive understanding about different actors involved in the street trading ecosystem, including wholesalers, middlemen and formal shops, as it is clear that street traders are only one link in a larger ecosystem of trade. That

\(^2\) Mali Kauli is a credit transaction in which a trader obtains goods with credit without collateral and can return unsold stock at the end of the day. Usually a Mali Kauli transaction is initiated by a request for assistance by a retailer, who has limited capital. For further information, see (Ogawa, 2006).
is, however, out of scope for this thesis, whose purpose is to design, develop and test a technology artefact.

3.4 QUANTITATIVE RESEARCH (PII)

This section is about quantitative research (PII). The combination of PI and PII makes a mixed research method. The informants were 245 street traders in Dar es Salaam, Tanzania obtained through convenience sampling. Data was analysed through descriptive statistics and basic measure of statistical association. Data was collected from May to July 2015.

To understand to what extent, the findings from the qualitative research in PI are relevant in larger street trading populations, a quantitative research study was done in line with the sequential research design of the mixed methods tradition (Creswell, 2014). Mixed research method is important because develops rich insights into various phenomena of interest that cannot be fully understood using only a quantitative or a qualitative method” (Venkatesh, Brown, & Bala, 2013 p.21). The quantitative research was done to complement, expand, confirm, and compensate the small sample and compare perceptions of issues observed in PI (Venkatesh, Brown, & Bala, 2013).

The central themes arising from the qualitative research in PI (Table 4) were combined into a structured questionnaire. The questionnaire was administered to a sample of $n=285$ street traders in Dar es Salaam, Tanzania. The return rate was 265, of which 245 qualified for data analysis, thus yielding an 85% response rate. The high response rate was attributed to the use of the hired data collectors (CBE students), of whom their relatives, friends, and family members are street traders.

The questionnaire was constructed based on qualitative research PI. The questionnaire consisted of 100 items on a 7-point Likert-scale (1=not at all true, 2=very little true, 3=slightly true, 4=moderately true, 5=quite true, 6=very true, 7=completely true). The main topics covered in the questionnaire were respondents’ demographics and profile, business background, marketing skills (product, price, distribution, promotion, customer relationship), bookkeeping, business management, business strategies, perception about empowerment, and need for business education. The collected quantitative data was analyzed by using descriptive statistics (mean and median), as well as basic measures of statistical association in relevant parts.

The sample was a convenience sample (Creswell, 2014), drawn from 3 municipalities of Ilala, Kinondoni, and Temeke in Dar es Salaam City. Street traders within the age range of 18–35 and who had business experience for more than one year were selected for the sample. The collected data was analysed for descriptive statistics (mean and median), as well as basic measures of statistical association (Spearman’s rank correlation coefficient, and Kruskall-Wallis’ H-Test) in relevant parts.
3.4.1 Overview of Results in PII

A wide variety of issues was revealed, confirming or rejecting the observations from PI in this sample and its base population. Regarding the business profile, several issues were asked from street traders. The findings show profit variation across the type of products sold. For example, the clothes traders were found to be the highest earners (4.5-8.5 USD) per day, while the rest are in the lowest earning group (less than 4.5 USD). The differences in distributions between groups were statistically significant as measured by Kruskal-Wallis H-test ($\chi^2(4) = 14.563, p = 0.006$). Similarly, the Ilala region was found to be the highest earning ($p=0.046$). Invested capital was found to correlate with daily profit (Spearman’s $\rho=0.486$, $p<0.01$), and experience was found to correlate with profit (Spearman’s $\rho=0.202$, $p<0.01$).

In regard to work and earn, it was confirmed that over 75% of traders work daily between 7 and 18 hours, with most traders earning an average of 140 USD per month, with no other employment opportunities available. In regard to products, it was found that some traders stick with one product whereas others change the products they sell.

Three main sources of products were identified, which were wholesaler, formal shops and Mali Kauli. Product pricing is based on tacit knowledge and negotiation. Sales location is determined by the mobility of the trader, estimates of traffic and estimates of availability of customers. Products are promoted through 1) displaying products on streets, 2) word of mouth, 3) discounts and allowances, 4) persuasive language, and 5) loudspeakers.

Figure 4 shows a street trader advertising products by using loudspeaker. Other street traders record advertising messages in loudspeaker, and make it play automatic to inform and persuade customers to buy.
In regard to customer care, the results confirmed that most street traders do not keep a list of customers, it is rare for them to have repeat communication with their customers and there is no contact after a sale is closed. In regard to keeping business records, several important results were obtained. It was confirmed that most street traders in Dar es Salaam do not record anything in books. This is because there is no perceived benefit of keeping books and there are no means or skills to record books. On the other hand, many street traders believe record keeping would be beneficial, which is a bit conflicting. In regard to future prospects, street traders wish for education, upgrading to formal business and access to capital. The main findings of PII are summarised in Table 5.
Table 5. Summary of main findings from PII.

<table>
<thead>
<tr>
<th>Category</th>
<th>Major findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business profile</td>
<td>1) Highest earners: clothes traders (Clothes, Foodstuffs, House items, Electronics, Miscellaneous) (p=0.006), 2) Highest earning area: Ilala region (Ilala, Temeke, Kinondoni) (p=0.046), 3) Invested capital and daily profit correlate (ρ=0.486, p&lt;0.01), 4) Experience correlates with profit (ρ=0.202, p&lt;0.01).</td>
</tr>
<tr>
<td>Work and earn</td>
<td>1) Over 75% work between 7 and 18 hours per day, 2) Most traders earn, on average, ~140 USD per month, 3) Most agree that they have no other employment opportunities</td>
</tr>
<tr>
<td>Marketing</td>
<td>Product-1) Product change behaviour varies, 2) Product quality varies, 3) Main sources of products: wholesaler, formal shops, and credit arrangements (Mali Kauli). Pricing- Based on tacit knowledge and negotiation. Sales location -The mobility level varies between traders, 2) Routes selection depends on estimates of traffic and availability of potential customers. Promotion- Main promotion methods are: 1) displaying products on street, 2) word of mouth, 3) discounts and allowances, 4) persuasive language and 5) loudspeaker. Customer management - 1) No list of customers, 2) no repeat communication with customers, 3) no after-sales customer care.</td>
</tr>
<tr>
<td>Record keeping</td>
<td>1) Most street traders do not record anything, 2) No perceived benefit, no skills or means, 3) Street traders do not have books or papers to record transactions, 4) Many traders acknowledge that record keeping would be beneficial, 5) Street traders do not sell on credit.</td>
</tr>
<tr>
<td>Prospects</td>
<td>Hopes to upgrade to formal system. Hopes of education and access to credit. Need to find how to upgrade them, need to design educational system contextualized to their ecosystem</td>
</tr>
<tr>
<td>Security and risks</td>
<td>1) Money is handled through both mobile money, as well as cash stashed in various locations, 2) Street traders do not have access to banking, 3) Bribes to city police, 4) Theft.</td>
</tr>
<tr>
<td>Mobile usage patterns</td>
<td>1) Communication with suppliers and customers, 2) calculator, 3) mobile money, 4) less for marketing.</td>
</tr>
</tbody>
</table>

3.4.2 Conclusions of PII

The aim of this research was to explore street trading in Dar es Salaam from an entrepreneurial perspective and to generate ideas for future technology innovation. This means that research was guided by the common entrepreneurial domains of marketing, bookkeeping, management, and strategic planning. The research was designed to focus on aspects that relate directly to entrepreneurship. The research questions of the study were:

- RQ1 (PII): What are the entrepreneurial needs, strengths, limitations and types of work undertaken by street traders in Dar es Salaam? (problem explanation)
- RQ2 (PII): What technology innovation opportunities arise from the entrepreneurial needs, strengths, limitations and types of work undertaken by street traders in Dar es Salaam? (requirement definition)
The results open the daily business life of street traders in Dar es Salaam from several different angles. First, the study shows that less educated people do street trade because other employment opportunities are unavailable to them, and that street trade is the path for them to accumulate capital to invest in formal business. Unlike other forms of business, street traders work for many hours, and their net income is sufficient for them to make a living, however they are constrained by many challenges that limit their productivity. Street traders are hoping for more successful and less risky occupations, though they lack strategies to gain them. Most of the street traders started business with small capital (less than 43 USD) and their average profit per day is less than 7 USD.

Concerning bookkeeping, street traders do not record their business transactions because they believe that their business is too small, hence there is no need for keeping records, moreover they lack record keeping skills. They compute some basic business calculations, however they don’t have a means for writing them down, though they see bookkeeping as a beneficial activity. Most of the street traders buy products from wholesalers or large-scale retailers on credit, however they don’t write these transactions anywhere. Furthermore, the street traders do not have the skills to compute the profit and loss of their business. Street traders reported not to have access to banking or bank accounts, but instead many of them reported to save their spare money in a ‘special box’, or sometimes through rotating savings associations (Mchezo) or through mobile money.

About marketing, many street traders do change their products from time to time to exploit the opportunities offered by change in demand and another marketing environment. In Dar es Salaam, street traders’ product choice is influenced by ease of sale, purchase costs, market uniqueness, customer needs, quality, and genuineness. The selling price is reached through negotiation. The factors that determine the final selling price are product buying price, business expenses, and demand. Largely, the price setting in street trade is based on non-systematic tacit knowledge and situations rather than thorough planning. Many street traders have a permanent street that they visit daily or weekly. Sometimes street traders change routes to find potential customers.

The main consideration when choosing the trading route was traffic and congestion. This means that street traders do not have a means to project and quantify the availability of potential customers. Concerning promotions, the findings show that the common methods applied by street traders are displaying products on the street, viva voce (word of mouth), discount and allowances, persuasive language, and loudspeaker. Street traders rarely communicate with their customers after making the sale. Furthermore, street traders have no systematic way of keeping track of their customers. Moreover, street traders lack repeat purchase customers. In addition, street traders do not have strategies to manage dissatisfied customers.
Many street traders have a dream to build a large formal business, however they do not have plans to realise the dreams. To minimise business threats, street traders carry the least possible amount of stock to avoid loss from theft or confiscation by police. Street traders consider access to additional capital, access to business education, legal recognition and formal business location to be important for their business growth and sustainability. A mobile phone is the only ICT tool accessible to many street traders and is used to communicate with suppliers and customers, for the calculator, for mobile money and little for bookkeeping and marketing. Currently most of the street traders do not have smartphones, but they have basic phones that are capable of USSD.

The results suggest a high potential for future DSR projects in several areas. These include customer profiling, customer databases, location information and pricing. Other areas include matchmaking between customers and traders, social networking between traders and customers, order and delivery management, weather information, and advisory applications. Additional areas may include electronic marketing, e-accounting (bookkeeping), and electronic business management (planning, organizing, controlling, and evaluating).

The results of PII support many qualitative findings of PI, thus confirming their relevance in the larger street trading population of traders in Dar es Salaam. The results are, however, explorative and descriptive, and many of the issues could benefit from research of a greater depth in the future. Examples of future research include mobile phone usage patterns and marketing behaviour. PII has two research questions, of which the second deals with innovation ideas based on the results, and it will be reported in the requirement definition section (Chapter 4).

### 3.5 PROBLEM EXPLICATION: CONCLUSIONS

This section will provide answers to three things that are required in the problem explication phase of a DSR project (Johannesson & Perjons, 2014, p. 92), which are: ‘define the problem precisely, position and justify the problem and find the root causes of the problem’.

First, the problem definition is weak business prospects of street traders. The street traders work long hours in challenging conditions, they walk long hours in search of customers with a variety of challenges that make their life tough and complicated. They have low education, they lack skills in business, and they lack means to access capital. They face several risks that they should deal with, including product confiscation, products ruined by weather, theft and paying bribes. Street traders have a passion to grow and build a large and formal business, however they do not have a means to realise these dreams.
Similarly, street traders have small capital, and they wish to increase it but they cannot borrow from the financial institutions since they have neither business records nor collaterals. Street traders wish to conduct business in a conducive and peaceful environment, though they live in fear and should run away from city police because they lack formal working premises. Street traders consider further business skills to be among the important factors for improving their business, yet the current skills development strategies are not aligned with street traders’ characteristics. Most of the street traders possess mobile phones, though it is used little to improve business growth. These findings suggest that street trade is important for many poor people in developing countries. However, street trading is constrained by many challenges.

Second, by positioning and justifying the problem, a DSR project should demonstrate that the identified problem is worthwhile to address, challenging enough and addressing it will have positive societal consequences (Johannesson & Perjons, 2014). Addressing the problem of street traders is important in several ways. The number of street traders in Tanzania is increasing abruptly, possibly due to lack of formal employment and decline in agricultural productivity in rural areas (Lyons & Msoka, 2010). This is contrary to dualists who considered the informal enterprises as extremely unproductive and believed they would wither away and die with modern, industrial growth (La Porta & Shleifer, 2008). Given this unexpected growth, researchers need to find out how to improve street trade and make it more productive and sustainable for economic growth.

In addition, street trade is an important source of employment, an opportunity to make a living or survive and a provision of low-priced goods and services around the world (Bhowmik, 2005). Moreover, the widespread availability of mobile phone coverage in Africa has opened opportunities for increasing informal workers’ productivity through better access to information and reduces production and transaction costs. Yet despite the proliferation of mobile devices, there are few ICT-based efforts for empowering informal workers.

Table 6. Business skills challenges of street traders in Tanzania.

<table>
<thead>
<tr>
<th>Business domain</th>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing</td>
<td>No competitor’s analysis, poor product choice, poor pricing, poor promotion technique, diseconomies of scale, poor customer management.</td>
</tr>
<tr>
<td>Bookkeeping</td>
<td>Lack of financial records, improper computation of profit, unable to set a reasonable selling price.</td>
</tr>
<tr>
<td>Management</td>
<td>No business plan, no evaluation and control, no targets, no separate entity.</td>
</tr>
<tr>
<td>Business strategies</td>
<td>No competitive strategy, lack of business differentiation, short run risk minimization strategies.</td>
</tr>
<tr>
<td>Customer management</td>
<td>No customer list/database, no frequent customer communication, no customer track, no repeat purchases, poor after-sale services.</td>
</tr>
<tr>
<td>Risk management</td>
<td>Many risks including product confiscation, heavy rain, theft, bribes to city police, no job security.</td>
</tr>
</tbody>
</table>
Third, Johannesson and Perjons (2014, p. 94) suggest a root cause analysis to investigate the potential causes of a problem. Johannesson and Perjons (2014, p. 95) recommend the use of an Ishikawa diagram, also called a cause-effect diagram, for analysing the root causes of an explicated problem. In this thesis, the root cause analysis was performed in two stages. First, the business skills challenges were distilled from the research findings and summarised in Table 6. Second, based on the research findings and the business challenges, the root cause analysis is presented in Figure 5, which summarises the potential root causes for the problem of weak business prospects of street traders in Dar es Salaam, Tanzania.

The results of PI and PII show that, the daily business life of street traders is restrained from multiple perspectives. There are no simple answers to what the exact causes are for the currently weak business prospects. Indeed, one might argue that the root cause for the challenges is the informal nature of the business, and suggest that the solution is economic development and formalisation of business. However, informal economy is currently widely practised in many developing countries, it has a significant economic impact and there are no signs of it going away.

The causes of these challenges are different depending on the type, and nature of activities done by a trader. Firstly, the weak business prospect in street trade is caused by lack of business skills. Street traders lack domain business skills like marketing, bookkeeping, and management skills. Business skills are important for a trader to plan, organize, coordinate, and evaluate business activities. Lack of any of these skills suggests poor business prospect. The details of these skills are summarized in Table 6. Lack of skills affects street traders’ business in many ways. For example; due lack of marketing skills street traders cannot set a competitive and reasonable price. The findings show that street traders do not keep business record partly because they lack skills. Lack of records means that, one cannot access formal finance or evaluate the business performance. Also, the street traders do not have business plan, sales target, or strong strategies as they lack these skills.

Another factor attributing to street traders’ poor business likelihood is weak business profile. Business profile of street traders include low profit, long working hours, insufficient working capital, and the informality of business. Business profile affects street trade in different ways; for example, low capital means small stocks hence diseconomies of scale; informality is directly associated with inside access to formal finance and the illegality of the business. Low profit in street trade limits the disposable income, saving, business growth, and business sustainability. Also, long working hours (up to midnight) affects lives and increases personal risks to street traders.

The findings show that, street traders operate in an unpeaceful business environment and are affected by many risks. Their products are being confiscated by police, robbed by thieves, and they should pay bribes to the police to do business. Generally,
their business is risky, insecure, and uncertain. These uncertainties reduce the number of their customers, erode profit, and create unsettled peace of mind. Evictions, accompanied by violence, prosecution, fines and imprisonment were experienced by tens of thousands of traders, although there have been conflicting estimates of the numbers involved (Lyons, 2013).

Street traders have mobile phones, however the usage of mobile phone to increase the efficiency of the business is less. The mobile phone has numerous application that can be used to assist traders in improving the efficiency of business. The mobile phone can be used to get education, promote products, set price, customer relationship, make plans and other business managerial business activities. Generally, mobile phones are underutilized opportunity to improve street trade. These findings suggest a need to design and develop mobile apps contextualized to street trade ecology. Also, there is a need give education on how the street traders can utilize the available mobile applications to increase the performance of the business.

Street traders have many hopes including to formalizing their business, accessing more capital and obtaining an education, things that always impend their business. However, they do not have a mechanism to get these. The current thesis has proposed several technological innovations (PII) that may uplift the street traders.

![Figure 5. Root cause analysis of weak business prospects.](image-url)
4 REQUIREMENT DEFINITION

4.1 CHAPTER INTRODUCTION

In design science research, problem explication (Chapter 3) is followed directly by requirement definition (Johannesson & Perjons, 2014). The goal of requirement definition is to identify and outline a solution to the explicated problem and to elicit requirements for that solution (Johannesson & Perjons, 2014). Thus, the requirement definition stage of DSR addresses the following question.

‘What artefact can be a solution for the explicated problem and which requirements for this artefact are important to the stakeholders?’ (Johannesson & Perjons, 2014, p. 103).

Requirement definition includes two main sub-activities, which are ‘outline artefact, and elicit requirements’ (Johannesson & Perjons, 2014, p. 104–105). In outline artefact, the type of artefact is chosen. Elicit requirements includes conducting research on previous documented solutions to similar problems, defining requirements based on the root causes identified in problem explication and gathering requirements from stakeholders (Johannesson & Perjons, 2014).

The previous chapter explicated the problems faced by Tanzanian street traders and analysed the problems’ potential root causes. Based on that analysis, in this chapter, the explicated problem is developed into requirements for a technology artefact. This was done in the following way. First, an idea generation workshop was arranged at the University of Eastern Finland’s School of Computing (UEF) to brainstorm ideas for technology interventions for street traders (Section 4.2). This was followed by selection of record keeping—which is one of the root causes identified in problem explication—to be the topic for the to-be-developed artefact. In line with Johannesson and Perjons (2014, p. 106), a review of previous research on attempts to solve similar problems was conducted (Section 4.3.1). This was followed using participatory methods to construct requirements for the artefact-to-be-developed (Section 5).

This chapter summarises the activities conducted for problem explication and concludes with a list of requirements for a record keeping application, contextualised for Tanzanian street traders (Section 4.4.4). The activities described in this chapter were conducted in Joensuu, Finland and in Dodoma, Tanzania. This chapter is based on PII and PIII of this thesis.
4.2 GENERATING IDEAS (PII)

This section is about the idea generation phase (PII). The idea generation was conducted through group brainstorming with UEF students at Joensuu, Finland, April 2015. The input for the workshop was root cause analysis, while the output was the list of potential technology applications.

4.2.1 Workshop Description

To generate ideas for technologies for street traders, an idea generation workshop was arranged at UEF in April 2015. The technology workshop was targeted at information technology and computer science students at masters and doctoral levels. Figure 6 shows the researcher giving an introductory lecture during the workshop. The advertisement to invite students to participate in the workshop was issued on 4 February 2015 by the school of Computing at the UEF. The interested participants were required to register before 24 March 2015.

The preliminary task for the study participants was to read the then-just-published research article PI (Mramba et al., 2015). The registered students were requested to read it before an introduction lecture to the workshop. The article was sent to participants three weeks before the workshop to give them sufficient time to read it. The introduction lecture took place on 27 March 2015, while group discussion sessions took place on 30 March 2015. Online students participated in the workshop via Adobe Connect Pro, while students physically present at the UEF campus met at classroom 2D309 (edTech lab), in Science Park, Joensuu.

After the introduction lecture, a question and answer session was arranged, which lasted for 40 minutes. In this way, the participants had a chance to gain knowledge about how street traders operate, their challenges, relationship with the government and the findings from the then-just-published research PI. In addition, participants had a chance to share their experience on street trade from their respective home countries. After the introductory session, participants were invited to the brainstorming session, which took place on 30 March 2015.

In the brainstorming sessions, two locally working groups and one online-based group participated. The first group consisted of four students, one from Russia, one from Nepal, one from Iran and one from Tanzania. The second group consisted of five students who originated from Ghana, Nigeria, the United Kingdom, Tanzania, and Uganda. The online group had students from Kenya, Tanzania, Nigeria, and Canada. The method used was group brainstorming. Each group was required to present their initial ideas during the workshop. The participants were then required to develop their ideas into a report, which was to be submitted one month after the
workshop. For those who successfully submitted their reports, one (1) European credit transfer system (ECTS) study credit was granted.

4.2.2 Workshop Results

In the workshops and resulting reports, street trading was discussed from multiple angles and viewpoints. To conclude, the reports showed that the workshop participants acknowledged street trading to be a complex business, differentiated by the level of national development, culture and region. Street trading and street traders also differ from one country to another based on the informal nature, connections to formal business, legal status, illegal aspects and connections to organised crime. For example, the workshop participants originating from Africa observed many similarities in street trading when comparing their thoughts on PI and their experiences from their home countries. However, participants from other continents had different viewpoints, as the phenomena of street trading may differ between contexts.

Figure 6. The introductory lecture of the Workshop, arranged at UEF.

Concerning technological interventions for Tanzanian street traders, several interventions were proposed. These included educational solutions, product database solutions, customer profiling applications, client-customer-wholesaler matchmaking applications, social networking for sharing ideas and daily stories, customer relationship management, and money handling technologies. Other ideas that were brainstormed during the sessions included the use of mobile vouchers as currency to enable effective record keeping, customer-driven matchmaking (customer searches for a
nearby product or service), and trader-driven matchmaking (trader searches for customers for specific products or services in a certain location). Table 7 includes the central ideas resulting from the brainstorming sessions and related scholars’ reports. The central ideas can be briefly summarised as follows.

First, the findings from problem explication clearly show that lack of systematic record keeping concerns the majority of street traders. Without record keeping, traders face difficulties in efficient business decision making, lack proper monitoring, and evaluation and face difficulties in accessing finance from financial institutions, or government subsidies. To mitigate this challenge, one important idea from the workshop was a mobile record keeping application to enable street traders to keep record of their business transactions anywhere, anytime and at a low cost. The goal of such an application would be to enable street traders to record their daily business transactions and to be able to see their financial position and related reports, hence provide them with a means to make wise business decisions.

Table 7. Application Ideas from PII.

<table>
<thead>
<tr>
<th>Category</th>
<th>Central idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matchmaking</td>
<td>GPS information, traffic advisory app, social network, location-based matching</td>
</tr>
<tr>
<td>Risk minimisation</td>
<td>Social network, weather information, advisory application</td>
</tr>
<tr>
<td>Formalisation</td>
<td>Advisory application</td>
</tr>
<tr>
<td>Improve trade supply chain</td>
<td>Online interaction with wholesalers, online product availability, online order management</td>
</tr>
<tr>
<td>Financial management and record keeping</td>
<td>Mobile currency, record keeping mobile app, capital access apps</td>
</tr>
<tr>
<td>Customer relationship management</td>
<td>Customer database app</td>
</tr>
<tr>
<td>Improve marketing</td>
<td>Product database and catalogue, electronic word-of-mouth, buyer-seller matchmaking, customer profiling, social network, pricing app, promotion technology</td>
</tr>
<tr>
<td>Strategic planning</td>
<td>Education and advisory app, management planning apps</td>
</tr>
<tr>
<td>Education &amp; skills development</td>
<td>Self-oriented education apps, online mass courses</td>
</tr>
</tbody>
</table>

Second, the findings from problem explication show that street traders’ marketing approaches are often weak and are based on tacit experience and knowhow, learned from other traders. Marketing is one of the key success factors for businesses of all sizes, and weak marketing is usually associated with business failure. To address these root causes for weak business performance of street trade, the workshop participants suggested a customer database application, which would help to categorise customers with different interests and needs, provide location information and give important information for pricing, marketing and customer care.

In addition, according to workshop participants, such a tool would help in creating sustainable long-term relationships with customers. For example, it could be used to track unsatisfied customers and see the appropriate strategies to attract customers for repeat purchases. Other observations from the workshop included an ICT
application that would advise the traders on the maximum buying price and the lowest price to accept per each product. This would be important for improving street traders’ business. It was also discussed that GPS information could help to improve matchmaking between street traders, customers and suppliers, improve logistics management, and help in identifying potential markets. Moreover, the workshop participants suggested that online applications could connect sellers and suppliers and might help to identify genuine products from counterfeit products.

As shown in problem explication (Chapter 3), Tanzanian street trade is constrained by several business risks including products confiscation by local authorities, weather, and theft. To overcome these challenges, the workshop participants suggested social networking, weather information applications and mobile currency applications. Social networks could, according to workshop reports, replace the traditional means of communication by street traders, for example, when they see certain risks. Better weather information would inform street traders so they could take precautions before the occurrences of rain. Mobile money would be useful to avoid theft of cash from street traders, the workshop participants suggested.

Like other types of informal workers, street traders possess a low level of education and business skills relevant to their daily business routine. Unfortunately, the available methods of skills development are not reasonable, based on the nature of business, since traders are always moving around the city to find buyers. To enable street traders to obtain business skills while doing business, the workshop participants proposed educational applications that make use of technology tools, e.g., education games. Without proper and self-oriented education, it will be difficult for street traders to improve their sales, minimise loss and maximise profit. Thus, a clear potential for education and educational technology for street traders was communicated by the workshop participants. The proposed educational applications included various kinds of online or mobile mass courses for teaching basic business skills, strategies and providing training and technical means for upgrading one’s business from an informal to a formal status.

4.2.3 Proposed Platform

Although not clearly specified for all the proposed ideas in the workshop, the mobile phone was the most common platform suggested by workshop participants. Currently, most of the street traders possess phones that are capable of running USSD-based applications, but they do not yet have smartphones. However, due to the rapid proliferation of smartphones, it can be estimated that soon more street traders will have access to smartphones. Therefore, smartphones were concluded to be the platform of design for the near future. However, simple USSD applications should not be totally ignored.
4.2.4 Discussion
It was also discussed in the workshops that in the developed world, there is an on-going trend of developing and launching mobile based business services such as house rental, food, other product delivery, and taxi and transportation services, which are enabling citizens with little prior business experience to easily start various businesses. In the developing world, there is also enormous potential for similar applications for various product and service offerings, as most people are already engaging in ‘self-made’ business activities.

4.3 TOPIC SELECTION AND TECHNOLOGY REVIEW

Based on the list of ideas for potential applications to increase the business success of Tanzanian street traders, for several reasons, record keeping was identified as the application idea with the most potential. First, the research in problem explication shows that many street traders do not record anything in the books. Lack of keeping records means that financial decisions are made based on memory and oral agreements, informal planning, assumptions of level of stock, and unconventional financial reports. Also, street traders cannot evaluate or monitor the performance of their business as they lack written records. One cannot claim the true state of one’s business if one does not have proper business records.

Second, record keeping is not only a problem for Tanzanian street traders. Lack of record keeping is a common challenge among small-scale traders in many developing countries (Orobia, Byabashaija, Munene, Sejjaaka, & Musinguzi, 2013). For example, in Uganda, research shows that most owner-managers of small enterprises keep records in their memory (Maseko & Manyani, 2011). In Zimbabwe, most small to medium-sized enterprises do not keep complete accounting records (Ademola, James, & Olore, 2012). In Nigeria, research found that the majority (87%) of small-scale entrepreneurs do not keep proper written records. In Ghana, studies show that most of the small-scale farmers do not keep proper farm records (Tham-Agyekum & Appiah, 2010). Thus, this challenge extends beyond Tanzania to other developing countries.

Third, it is globally well known that keeping business records allows for better-informed business decisions. Business records provide important information that is used by investors, lenders, and government and regulatory authorities with respect to business. For example, lenders use these reports to determine ability to pay, governments use these reports to determine taxes, regulatory authorities use these reports to determine license category. Investors need business records to decide which product line or type of business needs to be cut off, diversified or requires more investment.

The choice of bookkeeping application was also motivated by the fact that the project idea matched the resources available for designing and developing such an
application. The resources for development included one masters level exchange student from UEF to CBE, who is majoring in computer science and application design. The lead researcher of this project has an extensive background in business-related disciplines, while the software engineer (an exchange student from UEF to Tanzania) is experienced in Android mobile app development. Again, the time available was sufficient for this type of application, rather than some other proposed technology application, e.g., educational games, which would potentially require much more time to design and implement properly. Also, bookkeeping was one of the most interesting choices for street traders, as the results of PI and PII show. For these reasons, record keeping was selected as the topic for the artefact to be developed.

Based on this, a bookkeeping application was selected for the next phase of requirement definition. By using this application, users could perform several bookkeeping activities including controlling inventory, suggesting selling prices for various products and services, calculating profit and monitoring cash flow.

4.3.1 Technology Review

Following the recommendations of Johannesson and Perjons (2014), it was deemed necessary to review existing technologies that could potentially solve the problem or offer ideas for the design process. A search for existing applications was conducted.

It was found that there is a growing but still small trend of application development that is targeted to informal workers. Examples include applications for online shopping (Talbot & Marsden, 2011; Ntawanga & Alfred, 2015), record keeping, goal setting, and business planning (Sharma & Johri, 2014), tools for illiterate micro business owners (Emmanuel & Muyingi, 2013), and educational applications (Sharma & Johri, 2014). For example, small-scale farming is one domain that has attracted a variety of technology projects (Misaki, Apiola, & Gaiani, 2015). However, none of the surveyed applications could respond directly to the needs of Tanzanian street traders.

The review of existing bookkeeping applications show that there are few record keeping mobile applications for informal workers in developing countries (Frogtek, 2016; NASVI, 2016; Easybooks, 2016; Giridher, et al., 2009; Baguma, Myllyluoma, Mwakaba, & Nakajub, 2013; Sharma & Johri, 2014; Wasilewska & Wong, 2009). The findings of the review can be categorised into the following themes: design approach, services offered, targeted users, language used, simplicity, and costs associated.

Concerning the design approach, the majority of the available apps are silent about how they are designed (MiniERP, 2016; Uhasibu, 2016; SMeasy, 2016; Frogtek, 2016; NASVI, 2016; Easybooks, 2016). Much of the available information is related to marketing and usage. This scenario is mostly encountered in the bookkeeping apps found in websites (not in research articles). Other applications like these developed by Giridher et al. (2009) Sharma & Johri (2014) used participatory approach, Palser, (2011) used design science approach, and Wasilewska & Wong (2009) conceptual
framework. The review found little evidence of the use of systematic design science research in designing technology for informal workers’ record keeping.

As for the solutions offered, the web-based applications (MiniERP, 2016; Uhasibu, 2016; SMEasy, 2016; Frogtek, 2016; NASVI, 2016; Easybooks, 2016) offer a complete financial accounting app for small businesses, however it is too complex for street traders. Others studies explored a template approach called Financial Account Book (Wasilewska & Wong, 2009), a mobile-based app for teaching business women how to keep business records (Giridher, et al., 2009) and the usability needs of mobile applications for basic business (Baguma, Myllyluoma, Mwakaba, & Nakajub, 2013). These findings suggest a lack of research-based applications for street traders’ bookkeeping needs.

Regarding the language used, the review showed that most of the available applications, except for Giridher et al.’s (2009), run in some foreign languages. The use of foreign languages, particularly English, limits informal workers to fully enjoy the app, because most of them communicate in local languages. Thus, the findings suggest a need for a Kiswahili-based app for Tanzanian street traders.

The content and context of the reviewed apps are complex and difficult to apply in a street trade environment. The apps contain many features e.g., invoices, assets, and liabilities, which are not very relevant to street trade transactions, hence confusing. The results of PI and PII show that street traders need an ICT solution that is easy to use and relevant to their daily activities. Some of these applications are accessible only by paying a fee. The usage fees are usually higher than the net income of the street traders, which creates a barrier to Tanzanian street traders.

Furthermore, some of the available applications run on cloud (MiniERP, 2016; Uhasibu, 2016; SMEasy, 2016) and require internet for synchronisation, which is a major barrier for most street traders. Most of the available applications were designed for small businesses and not specific to street traders, therefore they may fail to apply in a street trade context.

In addition, the existing bookkeeping applications do not lay grounds for future DSR activities. The current projects lay much groundwork that can be considered for future design and development for improving street trade environment.

4.4 DEFINING REQUIREMENTS (PIII)

This section is about activities in problem definition. The problem definition was done through three workshops. The participants were business lecturers (CBE Dodoma), street traders (Dodoma) and a software developer (Finland). The main input was designing an idea, whereas the result was a list of requirements. These activities were carried out in CBE Dodoma from September to October 2015.
From generating ideas with students at UEF and selecting record keeping as the topic for the artefact to be developed, this DSR project proceeded to define the requirements more specifically. This stage was conducted in Dodoma, Tanzania, and street traders and business lecturers from CBE were invited to participate in the activities.

Defining the requirements for a record keeping application proceeded with preparation of the advertisements (see Figure 7) to call for potential street traders to participate in the project (PIII). The advertisements contained the name of the project, the condition for one to apply, how to apply and the expected benefits. The advertisements were distributed in various streets in Dodoma. In addition, CBE employees were informed to tell their friends, relatives and close family members about the project. In the requirement definition phase, a total of three workshops were arranged. Through the advertisement 17 street traders were successfully selected to join the project. Most of the applicants were, male hence a need to encourage female street traders to apply as explained in section 4.4.1. The street traders participated in these workshops are hereby referred as “participating street traders”. Most of the participating street traders (94%) were primary school leavers, 2 of them can neither read nor write. One of them (6%) was a college student studying Bachelor Degree in Accountancy-third year. All of them were doing business with a capital of less than 15 USD. All of them have reported to have dependants who were living basing on the income generated through street trade. The participating street traders were obtained from Dodoma Municipal. For each workshop attended each street trader were given 4.5 USD to cover transport expenses.
MRADI WA KUBORESHA BIASHARA ZA WAMACHINGA

01-09-2015

CHUO CHA ELIMU YA BIASHARA KAMPASI YA DODOMA KWA KUSHIRIKIANA NA CHUO CHA MASHARIKI MWA FINLAND KINATANGAZA MAOMBI YA KUSHIRIKI KATIKA MRADI WA KUBORESHA BIASHARA ZA WAMACHINGA.

MALLENGO NA FAIDA ZA MRADI

MALLENGO NI KUTENGENEZA TEKINÓLOJIA YA SIMU ILI KURAHISISHA BIASHARA ZA WAMACHINGA FAIDA KIU NI KUMUWEZISHA MMACHINGA KUFANYA BIASHARA KITAALAMU KWA KUTUMIA SIMU YAKE YA MKONONI

SIFA ZA KUSHIRIKI

- MSHIRIKI AWE NA MIAKA KATI YA 18-25
- AWEZE KUSOMA NA KUANDIRA
- AWE KUTUMIA SIMU
- UWE MMACHINGA UNAYETEMBEA

NAMNA YA KUOMBA

TUMA UJUMBE WA SIMU YA MKONONI (SMS) KWENDA 0715341836 UKITAJA JNA LAKO NA BIASHARA UNAYOFANYA. MUNISHO WA MAOMBI NI TAREHE 07/09/2015

Figure 7. Advertisement to invite people to apply for the project.
4.4.1 Workshop 1
In the first workshop with street traders, 14 men and 1 woman participated. All the street traders came with their products for sale. The workshop lasted for two hours and was conducted at CBE Dodoma. In this workshop, street traders were informed about the aim of the project, their responsibilities and the expected benefits. Furthermore, street traders were told their rights regarding continuing or quitting the project. Researcher used this opportunity to collect important information from them e.g., demographics, business profiles and individual expectations. The male street traders were encouraged to bring more female traders to participate in the project. After the introductions and the question and answer session, the proposed prototype was presented to participants for comments. Questions and comments from street traders (how it will work, how they are going to use it, what computations they can make, what are the benefits) were received and accommodated. Generally, all street traders were happy to see that new technology is being developed to improve their business. 

Figure 8. Street traders completing attendance forms in the first workshop. The street traders came with their products as it can be seen in Figure 8. In this workshop, the street traders were given an opportunity to tell the functions that they want to see in the proposed bookkeeping application. Profit and loss (daily, weekly, monthly, yearly),
inventory and cash flow, business expense, and selling price were among of the needed functions.

4.4.2 Workshop 2

The second workshop lasted for two hours and was conducted together with CBE lecturers, who were teaching business-related topics. The workshop took place at the CBE Dodoma campus. Twelve (12) lecturers participated. The purpose of the workshop was to show the lecturers a user case diagram and telling them how the proposed application will work. Hence, get their comments for further improvement. The main comments included the need to make the application simpler, useful, in the Kiswahili language, and that it should include debts and capital received.

The lecturers also showed their appreciation for the work done and showed their determination that an artefact like this could bring changes to street trade. Figure 9 below shows the workshop with lecturers at CBE Dodoma.

![Figure 9. Workshop with CBE lecturers at CBE Dodoma](image)

4.4.3 Workshop 3

The lecturers’ comments from Workshop 2 were taken into consideration and another, improved prototype was constructed. In Workshop 3, the improved prototype was presented to street traders. The workshop with street traders was conveyed in one of the classes at CBE Dodoma. In this meeting, we had two new female street traders, making a total of three females, and we also had an ICT lecturer with us. The aim of workshop three was to show the street traders how their comments (from workshop 1), and the lecturers’ inputs were consolidated and considered. Among the discussions in the workshop, one especially important comment was received from
the street traders: they noted that sometimes they fail to set a reasonable price for their products, hence requested the proposed mobile phone app to consider that challenge. Discussion with individual street traders revealed that it would be beneficial for them to see daily, weekly and monthly profits to be able to make business decisions. Also, street traders insisted the need to make the application be simple and run in Swahili. Figure 10 shows some of the street traders who participated in the third workshop.

4.4.4 List of Requirements

Based on the results of the three workshops, the requirements for the application were compiled together. Johannesson and Perjons (2014, p. 103) define a requirement as ‘a property of an artefact that is deemed as desirable by stakeholders in a practice and that is to be used for guiding the design and development of the artefact’. Further, Johannesson and Perjons (2014, p. 103) show that a requirement can concern the functions, structure, or environment of an artefact as well as the effects of using the artefact.

- **Functional requirements** refer to functions of the artefact and depend on the problem to be addressed as well as the needs and wants of the stakeholders. Functional requirements are often very specific (Johannesson & Perjons, 2014, p. 103).

- **Structural requirements** concern the structure of an artefact and may include attributes such as coherence, consistence, modularity, and conciseness (Johannesson & Perjons, 2014, p. 109). These attributes define, for example, the degree to which an artefact is divided into components and often refer more to the technical side of implementation in regards to, for example, how the implementation technologies are chosen.

- **Environmental requirements** address the relationship of an artefact and its environment, for example, to users or other artefacts (Johannesson & Perjons, 2014, p. 109).
Based on the work done in the workshops, in collaboration between the software developer of the project, the lead researcher of this thesis, the street traders and the business lecturers, a list of requirements was compiled. The following justifies the selection of the requirements for the application.

- Most street traders face the dilemma of deciding how much inventory to hold over a period. When one holds too much inventory, it is dangerous because the working capital is tied up unnecessarily. Too little inventory means that the street trader is likely to lose business because they will run out of stock. The findings in PI and PII suggest that sometimes street traders find themselves out of stock without their knowledge. To overcome these dilemmas, street traders need a mobile function to balance inventory in relation to sales. This is because they do not record products-in and products-out. To overcome such a challenge, street traders requested to have a mobile function that will enable them to know the current level of stock.

- Most of the street traders are less educated, with most of their business skills acquired informally and through experience. Some street traders are illiterate or semi-literate and can communicate only in their native language. They need an ICT solution that will meet their preferences and is easy to understand and use. Figure 11 shows one of the workshop participant explaining to other street traders, what functions she want to see in the proposed bookkeeping application.

- The best interfaces are almost invisible to the user. A simple user interface should correspond to a short and simple description. The workshop with street traders and business lecturers at the College of Business Education revealed the need for a simple, user-friendly interface for street traders.
• The findings from the requirement definition suggest a need for a Kiswahili-based mobile application. Kiswahili is a Bantu language widely used as a lingua franca in East Africa and having official status in several countries. Almost all street traders in Tanzania can communicate fluently in Kiswahili, therefore Kiswahili is the appropriate language for their application.

• Pricing can be a very difficult part of the marketing mix to get right, but getting it right can bring more revenue and profitability. The research from PI and PII shows that street traders lack the skills to determine how to arrive at the correct selling price. In street trade, the price setting strategies were found to be rather expected, but they were found to be based on non-systematic tacit knowledge and situations rather than thorough planning. Street traders noted that they sometimes sell their products at the lowest price since they lack the skills to determine how to arrive at the reasonable one. They raised a need for a function to assist them in setting a reasonable selling price.

• Most of the street traders cannot compute the profit and loss of their business, as their skills are very low. However, calculating profit and loss is important for evaluating business performance. Profit and loss account gives the actual information about net profit or net loss per a given period and shows how the profit is obtained. Street traders wanted the mobile function to compute loss and show business expenses over time (daily, weekly, and monthly).

Figure 11. Street trader explaining to the group what she wants to see in the proposed solution.
The summary of the requirements is presented in Table 8, which divides the requirements into functional, environment, usability, and structural requirements, based on recommendations by Johannesson and Perjons (2014). Functional requirements refer to the functions of the artefact and depend on the problem to be addressed, as well as the needs and wants of the stakeholders. In contrast, structural requirements related to the environment are typically more generic (Johannesson & Perjons 2014). Street traders were free to propose any function that might improve their business. Figure 11 shows one of the project participant explaining to the other street traders what she wants to see in the proposed application.

Table 8. List of requirements.

<table>
<thead>
<tr>
<th>Functional</th>
<th>Environment and usability</th>
<th>Structural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product database</td>
<td>Easy to use</td>
<td>Easy to develop further</td>
</tr>
<tr>
<td>Stock per product</td>
<td>Language: Kiswahili</td>
<td>Develop using free tools</td>
</tr>
<tr>
<td>Recording of sales and purchases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suggesting minimal selling price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring profits, losses and expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A week view, month view and day view</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to defining functional, structural and environmental–related requirements, Johannesson and Perjons (2014) suggest that requirement definition in DSR projects can include the formulation of goals on the effects of the artefact. These goals can, for example, include the anticipated positive benefits that an artefact is expected to have. In regard to this project, the goal formulation was that a successful first prototype be generated and initial tests completed in order to provide a good starting point for expanding the project in the future. The future expansion could mean technical expansion and business model related expansion, where larger scale usage tests would be conducted, possibly in collaboration with mobile operators.
5 DESIGN AND DEVELOPMENT

5.1 CHAPTER INTRODUCTION

In design science research, the activity directly following requirement definition is the design and development of an artefact, which addresses the explicated problem and fulfils the defined requirements. Designing an artefact includes determining its functionality as well as its structure and involves activities including: imagine and brainstorm, assess and select, sketch and build, and justify and reflect (Johannesson & Perjons, 2014). The design and development phase in DSR projects will result in prescriptive knowledge embedded in the designed artefact, descriptive knowledge about the design decisions taken, and their rationale. The input of design and development is a set of requirements, and the output is an artefact that fulfils the requirements and design knowledge (Johannesson & Perjons, 2014).

This chapter explains the design and development activities of this DSR thesis. The activities in this phase were conducted solely in Dodoma, Tanzania, on the premises of the College of Business Education’s (CBE) Dodoma campus. The activities include idea imagination, brainstorming (workshops), sketch and build (icon and application development), and justification of the solution. The participants in this phase consisted of 15 street traders who were recruited from the Dodoma area, one software developer who was an exchange student from UEF, and the lead researcher of this project. The methods used in this phase include participatory design. The main output of this section is a smartphone-based Android application for street traders’ record keeping, as well as knowledge about the design process.

This chapter is organised as follows. First, icon design activities are presented in subsection 5.2. Second, Android application development (sketch and build) are presented in Section 5.3. Third, user testing and demonstration are presented in Section 5.4. All the activities in this chapter were conducted in Dodoma, Tanzania, from September to December 2015. This chapter is based on PIII of this thesis.

5.2 ICON DESIGN & TESTING (PIII)

This section concerns icon design and testing (PIII). The icon design and testing activities were done through participatory design and brainstorming at CBE Dodoma in from September to December 2015. The participants were street traders, researchers and a software developer. The main input was requirement definition, while the result was an icon testing application and list of icons for a bookkeeping application.
5.2.1 Description of Icon Design

In this activity, the street traders were invited to attend several participatory design workshops at the CBE Dodoma campus. In the first workshop, the project participating traders were grouped in three groups, and the researcher, who acted as the facilitator of the meeting, opened the workshop. After this, the participants began to brainstorm icon designs that they would prefer for different functions of the to-be-programmed application. A list of application functions was listed on the blackboard of the classroom, followed by comments from the participating traders. Figure 12 below shows the street traders who participated in the icon design workshop at CBE.

After the first icon design workshop, a simple icon testing Android application was programmed for testing purposes. For each functionality of the to-be-developed bookkeeping application, the icon testing application was programmed to present several suggestions for an icon for that functionality. In the second gathering of the icon design and testing activity, the participants were handed mobile phones equipped with the programmed icon testing application. The participants then used the application to pick their preferred icons for each of the functionalities of the bookkeeping application, or a question mark if none of the icons was pleasing.

A total of eight sets of icons were presented, representing eight functionalities of the application. The functionalities were: 

- **Uza** (Sell)
- **Nunua** (Buy)
- **Matumizi** (Use)
Deni (Debt), Chakula (Food), Nguo (Clothes), Mtaji (Capital), and Vingine (Others). After the workshop, a list of icons to be used in the application was compiled. Figure 13 shows some of the icons used in the workshop.

![Figure 13. Proposed icons.](image)

### 5.3 SKETCH AND BUILD (ANDROID DEVELOPMENT)

This section describes the Android application development (PIII) carried out in CBE Dodoma. The method used is Android programming. The participants were a researcher and a software developer. The main inputs for programming were list of requirements and the proposed icons. The main output for this section was android working application for street traders’ bookkeeping.

From the icon design activity, the project proceeded to the sketch and build phase of a bookkeeping application, according to the specifications received from the require-
ments definition and design phase. This phase was done in collaboration with the software developer for the project, who was a computer science exchange student from the University of Eastern Finland (also a co-author in PIII), and the lead researcher (author of this thesis). Prior to sketch and build the researcher drew the use case diagram to show how the street traders will interact with the proposed system. The diagram had three core bookkeeping functions (sales, purchases, and expenses), products, price, and quantity. The diagram was accompanied with use case descriptions that describe, in detail, how the users will be interacting with the artefact. Each of the proposed applications were explained and related to other functions. The use case diagram and use case descriptions were discussed with the software engineer and the application requirements were then produced. These included changeable language, audio helper, icons for illiterate, should able to use with limited smartphone skills, adjustable capital/loan, show price (weekly, monthly, yearly), product flow, understandable icons, and business expenses. The core functions built for the artefact were: add product, sell, expenses, overview, history, and remove. The following subsection will detail the central use cases of the application.

5.3.1 Use case: Add product (Ongeza nyingine)

When the street trader obtains more stock of a product (through growing, buying from a wholesaler, making, or other means), he or she either first adds the product to the system if it does not already exist, or adds the amount directly to the existing stock, including the expenses of obtaining the product. Users can also take a picture (Piga picha) of the product or use an existing picture (+). The picture’s path is saved to the database and the picture is compressed and saved in the app’s local folder. The product is stored in the database and an absolute minimum selling price per unit is calculated. When the user adds a new product, it will appear in the list of products. Users can add multiple products with the same name if they want, since they might have, e.g., the same products of different quality to sell. New products can be added from the button (+ Ongeza nyingine).

5.3.2 Use case: Sell (Uza)

One of the main functions of any business is to sell. The sell function was designed to respond to the street traders’ requirement to see the sales volume, profit and recommended minimum selling price when selling products. When the user sells a product, the sales event is saved in the database. The name, amount, price, and time of sale is saved. The sell function is important because it is used as an input to calculate the trading profits and losses. The sell function has three sub-functions: amount (idadi), price (bei) and profit. Through the sell function, a street trader can see the suggested selling price and the profit margin that can be earned given the selling price. This is important because most of the street traders reported a lack of
necessary skills to set a reasonable selling price. Through the sell function, the user can set the price and quantity manually and the application will show the profit or loss. Figure 14 shows the sell function.

![Screenshot of the sell function](image)

**Figure 14. Uza (Sell).**

### 5.3.3 Use case: Expenses (Matumizi)

Expenses are the costs incurred during business. The value of business expenses is an important element to consider when computing profit and loss. The *problem explanation* and *requirement definition* showed that most of the street traders do not consider business expenses when reporting their profits. Thus, this function is important to enable the user to calculate the correct profit. The application offers an opportunity to post expenses once they occur in business. The expenses function has two entries: name of expenses (*jina*) and the amount of expenses (*bei*). Expenses are shown individually per product or per all products, in a way like the product overview screen. Figure 15 shows the screenshot of the expenses function.
Expenses for individual products can be looked at more closely and new expenses can be added. Through the application, a street trader can see the list and summary of all expenses accrued.

### 5.3.4 Use case: Overview

The product overview function is used to monitor the profit flow per product. This is important because street traders reported that they have no mechanism to know the flow of profits and losses per product. A red line shows the costs and the blue line shows the earnings (Figure 9—right). The user can switch between daily, weekly, and monthly views.

### 5.3.5 Use case: Explore history

Through the history function (Figure 18—right) the user can see the overall financial situation of the business. The summary of financial reports includes a list of the products sold, total expenses (*jumla ya matumizi*), gross sales (*mauzo ghafi*), and the balance (*jumla*), which is equal to the profit. This can be viewed per day (*siku*), week (*wiki*), or month (*mwezi*). This function is important because the street traders do not have a means to see the financial statements and position of their business.
5.3.6 Use Case: Remove product

There is also a trash can (*takataka*), consisting of removed products, sales and expenses. Items in the trashcan can be recovered or removed for good.

5.3.7 Example walkthrough

When a trader gets more stock of a product (through growing, buying, or making) he or she either adds the product to the system if it does not exist in the system (Figure 16—left), or adds the amount to the existing stock, including the expenses of obtaining the product. The item is stored in the database and an absolute minimum selling price per unit is calculated. The minimum selling price is shown in the product overview (Figure 16—right).

Figure 16. Add new product.
When selling, a trader activates the sell function (Figure 17—left) and the application suggests a selling price and shows how much profit that price will earn. The user can set the price and quantity manually, and the application will show the profit or loss. When the sales continue, the user can monitor the products’ sale progress through the profits and losses diagram in the overview screen (Figure 17—right). A red line shows the costs, and the blue line shows the earnings. The user can switch between daily, weekly and monthly views.

![Image of a mobile application interface showing a product and its sale progress graph.]

Figure 17. Sale.

When the user increases the quantity of a product that is in the database, the application calculates a new absolute minimum selling price for the product. This also adds to the expenses. The functions also include removal of a product from the database. New expenses can be added from the expenses window (matumizi), (Figure 18—left). Expenses are shown individually per product as in the product overview screen. Expenses for individual products can be looked at more closely, and new expenses can be added.
From the history (Figure 18—right) the user can see the overall financial situation. This includes a list of sold products. This can be looked at more closely and a graph will show the total expenses in red and the total earnings in blue. At the bottom screen the user can see the total expenses, earnings and subtotals. There is also a trashcan (takataka), consisting of removed products, sales and expenses. Items in the trashcan can be recovered or removed for good.

5.3.8 Technical description of application

The application was programmed using Android Studio\(^3\). System models were created with Dia\(^4\). The application contains a total of 2,100 lines of code. The design included a Structured Query Language (SQL) database for storing user data, for which SQLite was used. The database scheme included three tables, which are accessed

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\(^3\) Android Studio is the official integrated development environment (IDE) for the Android platform. https://en.wikipedia.org/wiki/Android_Studio

\(^4\) Dia is free and open source general-purpose diagramming software, developed originally by Alexander Larsson. https://en.wikipedia.org/wiki/Dia_(software)
through a Cursor object. To meet the requirement for maximum simplicity, the application was programmed to include only the basic requirements for keeping track of product and money flow for the street traders. The following requirements for the mobile devices were set. The devices should have a touchscreen, camera, 700MHz CPU, 256MB RAM, run Android 2.3 or higher and should be available from the local markets at a low price (43.3 USD). Based on these criteria, Tecno Y3 was chosen, and 15 of these phones were obtained to be used for this project. Tecno Y3 phones have 1.0 GHz dual-core Cortex-A9, 4.0 in. touchscreen (480 x 800 pixels), 512MB RAM, 2MP front camera, A-GPS and they run Android 4.4 KitKat.

5.4 USER TESTING & DEMONSTRATION

This section discusses the demonstration (PIII) done in Dodoma, Tanzania. The methods used were usability testing, training workshops and field testing. The participants were 15 street traders, a researcher and the software developer. The main inputs were the smartphone Android working application, while awareness about the app and usage knowledge were the results.

The fourth activity in design and development was to test the mobile application for the street traders’ bookkeeping and demonstrate the application to interested stakeholders. This section also corresponds to the demonstrate artefact phase (Johannesson & Perjons 2014, p. 133), which addresses the question ‘How can the developed artefact be used to address the explicated problem in one case?’

The goal was to show how the developed artefact can be used to address the lack of bookkeeping among the street traders. The main activities were to describe what and how the developed solution works. First, this included training workshops, where the usage of the developed smartphone application was taught to the participating street traders. Before the session, the researcher explored the participants’ history in smartphone usage. Four (4) participants had a background in smartphone usage. The participants were grouped in four groups per their experience in smartphone usage. All the use cases of the application were taught. Figure 19 shows a researcher teaching the street traders on how to use the designed application.
After the training was complete, the participating traders were handed smartphones for a period of two days. After the testing period, another workshop was arranged where the traders gathered together to report their experiences from the testing period. It was found that 10 out of the 15 street traders could add the transactions to the application correctly. A list of common usability problems was obtained, including: erroneous insertions, double insertions of transactions, and failures with units and values per products. This activity demonstrated that the application has the potential to solve some of the street traders’ business challenges (Johannesson & Perjons, 2014, p. 133).

The application was developed more based on the suggestions and a new version was installed. A second usage test was conducted during a CBE college graduation ceremony, where the traders were invited to do business. The new version contained weekly, monthly and daily views, and was also able to suggest a minimum selling price when making a sale. Figure 20 shows a researcher, demonstrating the application to guest of honour (Bahi District Commissioner) during graduation ceremony at CBE Dodoma.

After this, the street traders were given the application to use for a testing period. A telephone interview was conducted three weeks afterwards, which confirmed that some of the traders had used the application, however, it was not certain to what extent the application was in use or if the traders found it beneficial. Major challenges included lack of power to charge the phone, usability challenges, unintended uninstallation, and forgetting to record transactions.
Several improvement ideas and ideas for future functionalities rose from the testing activities. First, for illiterate street traders, the application needs to be developed to be still simpler and easier. This is an important target group. Future suggestions include voice helper, further development of icons, and better use of symbols and photos. Second, the future development includes suggestions for locations and times to sell and buy. This is a crucial function of an application because an estimation of customer movements is not easy for street traders. Third, the data could be stored in a cloud. This would enable the collection of data from all traders and related inferences, allowing the possibility of better informed suggestions and making business analytics and intelligence possible.

Figure 20. The application was demonstrated during at CBE, Dodoma, in 2015.

5.5 OBSERVATIONS FROM DESIGN

The design process encountered several challenges. However, none of them negatively affected this project as they were managed correctly. Table 9 below summarises the challenges encountered and how they were managed.

Through workshop 1 to 6, the research observed absenteeism and late comers. Some of the project participants arrived 20 minutes after the session started. To overcome this challenge, researcher used to negotiate with street traders to find appropriate time and venue for workshop. Also the recap sessions before and after the workshop were used to cover the gap for those who missed the session. The
second challenge was a few numbers of project applicants that minimized the room for selection. The expectation was to receive more than 50 applicants, hence screen to get most appropriate candidates. The researcher encouraged the successful applicants to tell their friends about the project and invite them to participate. Through this mechanism the project got 2 new female street traders.

The majority of the street traders participated in this project had not ever used the smartphone before. Out of 15 street traders participated in the demonstration (section 5.4) it is only 4 who had a background in smartphone usage. To overcome this challenge, the experienced street traders, researcher, and software engineer provided training on how to use smartphones to them. Also, the extra time for practising how to use smartphones were provided to the learners. There was a language problem. A software engineer couldn't communicate with Kiswahili (Tanzanian native language). To overcome this challenge, the researcher used to translate everything in Kiswahili. Also the bookkeeping application for street traders were kept in Kiswahili language.

At the first workshop, some of the street traders had skeptical expectations that, from the project they will get capital. They thought that since the project was titled “empowerment” in the advertisement then they would be given capital or money. In many parts of Tanzania when you mention the word “project for empowering” then people will expect to get money or capital from it. To overcome this challenge, a researcher of this thesis used the first workshop to educate the participants about the goals, objectives, and the outcomes of the project. Another challenge was too low level of education among the participants. 14 participants had only primary school education, 1 participant was a bachelor degree student at the college. 2 participants were primary school leavers but illiterate. To overcome this challenge, the designed mobile application was kept simple to use but useful in business. The illiterate street traders dropped themselves from the project.

Table 9. Design challenges.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absenteeism and latecomers caused by family responsibilities.</td>
<td>Negotiate date, time and venue in advance—recap before and after the session. Special session for latecomers.</td>
</tr>
<tr>
<td>Small number of applicants, hence affecting the screenings that were to be done.</td>
<td>Use successful applicants to bring other traders.</td>
</tr>
<tr>
<td>No background in smartphone usage.</td>
<td>Use experienced users to teach others—provide extra time for practising.</td>
</tr>
<tr>
<td>Can’t speak or write in English.</td>
<td>Use a local researcher to translate—customise application in Kiswahili language.</td>
</tr>
<tr>
<td>Scepticism</td>
<td>Use the first day to educate participants about the goals and objectives of the project.</td>
</tr>
<tr>
<td>Two applicants were illiterate.</td>
<td>The illiterate applicants dropped themselves.</td>
</tr>
<tr>
<td>Low level of education.</td>
<td>Develop simple but useful application.</td>
</tr>
</tbody>
</table>
There are several bookkeeping or accounting applications for informal workers in SSA, though none of the available existing applications were found to respond directly to the needs of Tanzanian street traders. First, most of the applications were found to be either too confusing for street traders or not available in the Kiswahili language. In addition, an important reason for starting this project was co-creation. Thus, the larger goal of this project, beyond a single bookkeeping application, was to lay the groundwork for future DSR activities. When the users are involved as equal members they are empowered, and this is also a great way for the different project participants to learn to understand each other. Also, building our own application would allow for the easy addition of new functionalities in the future. This would not necessarily be possible if an existing application was used.

5.6 CONCLUSIONS OF DESIGN & DEVELOPMENT

This chapter showed how the problem explication and requirement definition were used to design and develop a bookkeeping application contextualised for Tanzanian street traders. The design and development was done in close collaboration with the street traders and relevant stakeholders, such as business lecturers. This chapter also tested and demonstrated (Johannesson & Perjons, 2014, p. 133) the application with several use cases. Table 10 present summary of workshops conducted during problem definition, design, development, and demonstration.

Table 10. Summary of the workshops.

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Participants</th>
<th>Main Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop 1</td>
<td>15 street traders</td>
<td>Introduction, inception, familiarization, presentation of use case diagram</td>
</tr>
<tr>
<td>Workshop 2</td>
<td>12 business lecturers</td>
<td>Discuss early prototype</td>
</tr>
<tr>
<td>Workshop 3</td>
<td>17 street traders</td>
<td>Discuss the improved prototype &amp; user requirements</td>
</tr>
<tr>
<td>Workshop 4</td>
<td>15 street traders</td>
<td>Icon design</td>
</tr>
<tr>
<td>Workshop 5</td>
<td>15 street traders</td>
<td>Demonstration of the 1st version of mobile application for street traders’ bookkeeping</td>
</tr>
<tr>
<td>Workshop 6</td>
<td>15 street traders</td>
<td>Report usage experience (Evaluation)</td>
</tr>
</tbody>
</table>
6 EVALUATION

6.1 CHAPTER INTRODUCTION

Evaluate Artefact—‘The evaluate artefact activity determines how well the artefact fulfils the requirements and to what extent it can solve, or alleviate, the practical problem that motivated the research’ (Johannesson & Perjons, 2014 p. 138).

As the previous chapters demonstrated, this design research project started by gaining an understanding of the phenomena of street trading, then conducting a mixed methods research approach to explicate the problems of street traders and define requirements for technology artefacts. The requirement definition proceeded, through workshops in Finland and Tanzania, to select record keeping as the topic for the to-be-developed artefact, to gather an implementation team and finally to design, develop, and test a technology artefact.

An important part of DSR projects is evaluation. It is crucial to understand the successes and failures of the developed artefact and its creation process. The literature on DSR is unanimous on the importance of evaluation, but provides a range of options as to the attributes, methods, and frameworks of evaluation. Common attributes to evaluate include utility, quality, efficacy, functionality, completeness, consistency, accuracy, performance, reliability, usability, and fit with the organisation (Hevner, March, Park, & Ram, 2004), side effects, weaknesses, and areas of improvement (Venable, Pries-Heje, & Baskerville, 2012), ethicality and elegance (Checkland & Scholes, 1990).

In this chapter, this project and the created artefact are evaluated according to the evaluation goals and principles laid out by Johannesson and Perjons (2014). This evaluation is approached from three viewpoints adapted from the suggestions of Venable, Pries-Heje, and Baskerville (2012) and Johannesson and Perjons (2014). They include the utility of the artefact, with a focus on the usability and usefulness of the developed application for the user group and potential side effects, the implementation principles of the project, covering the full process and its methodology choices from problem explication to design and development, and comparison to related projects, in order to relate the project to the global knowledge base of similar or related M4D projects (PIV).

6.2 UTILITY OF THE ARTEFACT

The evaluation of the artefact should answer the question: ‘How well does the artefact solve the explicat ed problem and fulfil the defined requirements?’ Different types of evaluation require different research methods (Venable, Pries-Heje, & Baskerville, 2012; Johannesson & Perjons, 2014). A common distinction between evaluations is between
the *ex-ante evaluation*, which means that an artefact is evaluated without being used or even being fully developed, and the *ex-post evaluation*, which requires the artefact to be fully employed (Johannesson & Perjons, 2014). Another broad categorisation is between *naturalistic evaluation*, where an artefact is evaluated in real practice, and *artificial evaluation*, where an artefact is evaluated in an artificial setting (Venable, Pries-Heje, & Baskerville, 2012; Johannesson & Perjons, 2014). Table 11 shows this categorisation and roughly situates research methods suitable to different kinds of evaluations to the matrix.

Table 11. Categorising different types of DSR project evaluations, and related research methods used (Johannesson & Perjons, 2014).

<table>
<thead>
<tr>
<th></th>
<th>Ex-ante</th>
<th>Ex-post</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Naturalistic</strong></td>
<td>Action research</td>
<td>Action research</td>
</tr>
<tr>
<td></td>
<td>Focus group</td>
<td>Case study</td>
</tr>
<tr>
<td></td>
<td>Interview</td>
<td>Ethnography</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Focus group discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Participant observation</td>
</tr>
<tr>
<td><strong>Artificial</strong></td>
<td>Mathematical or logical proof</td>
<td>Mathematical or logical proof</td>
</tr>
<tr>
<td></td>
<td>Computer simulation</td>
<td>Computer simulation</td>
</tr>
<tr>
<td></td>
<td>Lab experiment</td>
<td>Role-playing simulation</td>
</tr>
<tr>
<td></td>
<td>Informed argument</td>
<td>Lab experiment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Field experiment</td>
</tr>
</tbody>
</table>

In this project, the evaluation of the *artefact* remains between *naturalistic evaluation* and *artificial evaluation*, because some of the features were evaluated in a classroom setting, while other functionality features were evaluated while the end-users were using the application and conducting their everyday business activities. This means that the participants used the developed application as a part of their actual business activities for a test period. Additionally, this thesis presents an evaluation of an un-instantiated artifact that didn’t yet go beyond the first iteration hence ex-ante evaluation (Venable, Pries-Heje, & Baskerville, 2012). The developed application, although functional in what it can do, is still relatively simple and needs further development and testing before it can be considered for *ex-post evaluation*.

### 6.2.1 Usability

The testing group of 15 street traders could use the application for a test period and add their business exchanges to the artefact, as shown in Chapter 5. Several usability challenges of the developed artefact were found, such as double insertions and failures in locating units and prices. The main usability challenges encountered during the testing of the application were the following:

- Double insertions
• Failures in locating units and values per product
• Failures in differentiating purchases and sales when inserting transactions

6.2.2 Fulfilling the defined requirements

Regarding the defined requirements, the artefact does fulfil them. This means that by using the artefact, this project has proven that the application allows for insertion of business transactions, and that the target user group (the street traders) can use the application, add and explore their business transactions, and make different business decisions based on the applications (profit/loss).

In addition, it is necessary to bear in mind that the developed application can be considered an early prototype. The project was implemented with relatively small resources, and it should be considered more as a basis for future DSR projects instead of evaluated as a product ready to be used. Thus, its impact lies not only in the direct applicability or utility of the developed artefact but also in opening an avenue for future research and development efforts. Also, its utility is in bringing the idea of DSR and technology innovation activities to local contexts, thus, possibly, sowing the seeds for future efforts to design a variety of artefacts to address societal and business challenges. However, these kinds of impacts are not directly measurable, and it is not possible to know to which extent they did materialise.

The most important question in evaluation is ‘How well does the artefact solve the explicated problem?’ (Johannesson & Perjons, 2014). When reflecting on the problem explication, which is distilled to weak business prospects, and is potentially caused by several factors, that the developed artefact can’t alone solve the explicated problem. However, if further developed, it has the potential to become one important part of solving the challenges of street traders. To address a problem of this scale, several other efforts are also required. Those efforts may include economic, political, educational efforts, and interventions.

Also, most street traders in Tanzania do not currently have smartphones, but they use regular types of USSD-capable mobile phones. However, it is very challenging to design usable applications for the USSD platform, and there is little evidence of a positive impact from such applications. On the other hand, estimates show (see, for example, Poushter, 2016) that smartphone ownership is increasing in emerging economies, and thus smartphones will soon become available to an increasing number of informal workers. Therefore, working on the platform currently available would be short-sighted.
6.3 IMPLEMENTATION PRINCIPLES

What has been written about DSR evaluation focuses mostly on how to evaluate the artefact. Less is written about how to evaluate the implementation principles, although that is listed as one important target for evaluation (Johannesson & Perjons, 2014). In this section, the project implementation principles will be evaluated per each of the phases in this DSR project. For each of the phases, interaction, teamwork, ways of working and participators are considered. Table 12 summarises the main activities in DSR implementation.

Table 12. Implementation activities in each stage of DSR.

<table>
<thead>
<tr>
<th>DSR stage</th>
<th>Implementation activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem explication</td>
<td>PI focused on understanding street traders’ activity strategy and skills and proposed a mobile intervention.</td>
</tr>
<tr>
<td>Requirement definition</td>
<td>Innovation workshop (PII), workshop with street traders (PIII), workshop with business lecturers (PIII). Several technology possibilities to overcome street traders’ challenges were proposed.</td>
</tr>
<tr>
<td>Design and development</td>
<td>A team consisting of a software engineer (Finland), a researcher, and street traders (Tanzania) designed a mobile application for street traders’ bookkeeping (PIII).</td>
</tr>
<tr>
<td>Demonstration</td>
<td>Workshop to train and show the street traders how the application works (PIII).</td>
</tr>
<tr>
<td>Evaluation</td>
<td>In class and onsite evaluation was done. An evaluation of the available technologies for informal workers in Africa was done in PIV.</td>
</tr>
</tbody>
</table>

Problem explication

The project started from considering a complex, multifaceted problem of street trade in developing countries in general, and in Tanzania. There was little research available about technical interventions to support this user group, which could be used as a model to act. Therefore, research was inevitably required to understand street traders’ business activities, skills and strategies to propose mobile technology-based solutions to improve their business prospects. The findings show that street traders operate in a challenging environment and should employ several additional activities and strategies as compared to formal businesses. For example, the study identified lack of skills in marketing (product selection, pricing, distribution, promotion, and customer service), lack of record keeping, poor business management, weak risk management, and lack of strategic planning. These shortcomings negatively affect the growth and sustainability of street trade, hence a call for interventions.

Street traders are a key group of the informal economy in major cities around the world, particularly in developing countries. Street trade has been attractive to many youth and women in poor countries because other employment opportunities are not available for them, as they do not have sufficient resources (skills and capital) to access or form formal enterprises. However, the problem explication (PI) has found
many problems that hinder the efforts of street traders to withdraw from the poverty trap. The existing literature in Tanzania and the rest of the world focuses on a limited perspective of street traders, e.g., informality and formalisation (Lyons & Msoka, 2010), legal status (Lyons, 2013), characteristics (Asiedu & Agyei-Mensah, 2008; Wongtada, 2013), confrontation with authorities and policy management (Onodugo, Ezeadichie, & Onwuneme, 2016). Little has been done in relation to improve efficiency, particularly with the use of ICT.

**Requirement definition**

The problem definition was done in the innovation workshop (PII) and workshops with street traders (PIII). The authors of PII were drawn from Tanzania (business), Finland (computer science) and Ghana (computer science), hence contributing a mixture of multicultural and multidisciplinary input. PII confirmed that street trading in Dar es Salaam is a survival-based activity that is conducted by a mass of traders with low levels of education who have little other employment or educational opportunities available to them. The study has put forward several technology interventions to improve the street trade. The innovation workshop, which involved computer science students from different countries around the world, has provided important inputs for defining the requirements.

Through this workshop the project received an international quality. Bookkeeping was chosen because of its importance in business, the available resources (time and expertise) and the needs of street traders. What is exceptional about this project is that the street traders participated in the project as more or less equal members. Many technology projects have a *technology-push* model, where applications are developed elsewhere and then brought to developing countries, and the business benefits go to telecom companies or large software companies somewhere else. Thus, this was a locally initiated grassroots level project, but with international and intercultural communication, which promoted the ideas of participatory design and co-creation among groups of people from different cultural backgrounds.

**Design and Development**

The design and development phase was done in Dodoma, Tanzania. The team, consisting of a software engineer (Finland), a researcher (Tanzania) and the street traders (Tanzania), participated in activities related to designing a mobile application for the street traders. The team members met several times to exchange ideas about the structural and functional requirements of the proposed applications. One difference between this project and others is that the design was done in the street traders’ hometown and all their inputs were considered, hence instilling them with a sense of ownership. The street traders and CBE lecturers (2nd workshop) appreciated the project. It is uncommon to see marginalised people like street traders being involved in the design and development process. The street traders’ attention to requirement
definition, demonstration and evaluation was very satisfactory. In the beginning, the street traders were not sure if technology could improve their record keeping, however the researcher used an example of mobile money (which is common among them) to explain the power of technology, expressly via mobile phone.

**Demonstration**

A workshop was arranged at CBE to teach street traders how to use smartphones and the developed application. The meeting took place in one of the CBE classes. The main lessons of the day were how to switch smartphones on and off, open and browse the app, post transactions and view financial reports produced by the app. The researcher, software engineer and traders who had experience in using smartphones helped train others. The session was very interesting and fun for those who had never used smartphones. The street traders were requested to fill out the agreement form before being given the mobile phone to ensure proper usage as instructed. All the mobile phones were provided by CBE and therefore needed to be taken care of. All the mobile phones were in place through the end of the project, and street traders were using them for various social and business activities. Figure 21 shows street traders practicing how to use the bookkeeping application during the workshop. It was funny for some street traders to use smartphone for the first time.

![Figure 21. Street traders practicing how to use the bookkeeping application during the workshop.](image)
Evaluation

Street traders were invited to trade at CBE during the 2015 graduation ceremony. The researcher and software engineer also attended the ceremony to demonstrate the application. The researcher and software engineer used this gathering as an important chance to observe how street traders were using the application. The findings show that all the street traders were using the application successfully. After each sale, the street traders were posting the transaction to the mobile phone. From time to time, they were checking the profitability, cash flow, and summary of their business. Additionally, a telephone interview was done with street traders, the goal being to evaluate their usage. All street traders reported being able to see the record of their sales, purchases, and expenses. However, they didn’t indicate how they are using it to make various business decisions. A systematic literature review was done in PIV to evaluate the ICT interventions for informal workers in SSA (see the next section).

6.4 COMPARISON TO RELATED PROJECTS (PIV)

One of the goals of artefact evaluation is to ‘compare it to other artefacts that intend to address the same or a similar problem’ (Johannesson & Perjons, 2014 p. 137). The new artefact is expected to deliver more added benefits compared to the existing artefacts.

PIV reviewed recent ICT projects and initiatives designed for the informal economy in SSA through the lens of design philosophies, applied technology and the services offered. The purpose of PIV was to learn what has been done so far to address the challenges of informal workers through ICT. Thus, PIV contributes to the body of knowledge related to the use and development of ICT for informal workers in SSA. The summary of the findings in PIV is presented in Table 13.

The findings from PIV show that most of the ICT solutions for informal workers in Africa are designed with few inputs from the potential users. There is only minimal use of user-centered design, such as participatory design research. Most of the identified ICT solutions for informal workers were designed because the designers either experienced a problem or saw an opportunity for making a profit. Most of the available projects do not explain thoroughly how the design process was done.

Many ICT solutions for informal workers run on mobile phones. These include USSD, mobile apps, mobile web, SMS, and voice calls. The choice of mobile phones is attributed to accessibility, availability, and affordability. Most of the informal workers are low income earners, therefore they can afford to buy only low end mobile phones but not smartphones and computers.

The identified ICT solutions cover various informal workers’ challenges, e.g., information flow, education, record keeping, marketing, and production-related challenges. However, many of the solutions cover the challenges arising from production and they ignore pre-production challenges. Likewise, the majority of the available
ICT projects do not consider the characteristics and peculiarities of informal workers, such as income, education, attitudes, knowledge, and perception. In addition, most of the identified ICT projects do not directly address the requirements that cater to the needs of informal workers.

Table 13. Summary of the major findings in PIV.

<table>
<thead>
<tr>
<th>Category</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Lack of information about the design approach, mismatch between the designs and local users’ reality, little use of user-centered design approaches.</td>
</tr>
<tr>
<td>Technology channel</td>
<td>Many applications run on mobile phones, particularly via USSD, mobile apps, mobile web, SMS and voice calls.</td>
</tr>
<tr>
<td>ICT solutions for informal workers</td>
<td>Marketing information, education, accounting (record keeping), animal diseases and medication, insurance services, weather information, networking and mobile money.</td>
</tr>
<tr>
<td>Informal workers’ challenges solved</td>
<td>Efficient information flow, networking farmers with key stakeholders, insurance, auction, marketplace, weather updates, marketing information, farming management, disease prevention, education, record keeping and advisory services.</td>
</tr>
<tr>
<td>Other findings</td>
<td>Little data about adoption and usage. Only a few projects in the domains of education, financial management and access to finance. Most ICT solutions focus on post-production challenges. High costs of mobile money may limit its usage.</td>
</tr>
</tbody>
</table>

6.5 RELATIONSHIP WITH OTHER M4D PROJECTS

There are several mobile applications for development in Africa, however only a few of them can fit into the street traders’ ecology. The current project is different from the others in several ways.

First, the current application was designed in a highly participatory approach. Street traders were involved in every stage, from idea explication to artefact evaluation. This was an opportunity for the street traders to put forward their needs, comments and other contributions for the design input. The street traders were happy to see what they proposed had been included in the design solution. This is uncommon to many M4D projects in Africa. Usually, Africans receive the technologies that have been designed elsewhere, sometimes with little or no input from the actual end users (Udo & Ifinedo, 2012). Most of the ICT solutions for informal workers are designed because the designers experienced a problem or see an opportunity to make a profit from the challenge. Users’ involvement in solution development improves the quality of the solution arising from requirements that are more accurate, avoids the cost of developing functions that would be useless to users, improves the degree of system acceptance and contributes to more efficient usage (Damodaran, 1996).

The second difference between the other M4D applications was the approach used to get to know the street traders’ challenges that need interventions. Three research studies (PI, PII and PIII) were used to explicate and define the problem and
user requirements. The research was done rigorously, using relevant methods to devise a dynamic ICT intervention (Hevner, March, Park, & Ram, 2004). Most of the available information on M4Ds in Africa does not show how the problem was explicated and defined. The information is also not backed up by published research. Most of the information available on M4D projects concerns functional features and promotional information to encourage people to use it.

An additional difference was the team composition. The project team involved a multicultural, multidisciplinary, multitalented mix of people, including the street traders. The project brought together underground street traders who are constrained by multiple business challenges, a business management expert (the researcher) and the software expert. Such a combination helped increase the performance of the designed solution because it brought together a group with multiple skills and different cultural backgrounds and experiences. A multidisciplinary design approach is recommended when developing ICT interventions to achieve higher user acceptance and efficient information transfer, particularly in developing countries (Parmar, 2009).

Another difference from the existing M4D projects was a level of contextualisation. The current M4D project was contextualised to meet the requirements of the street traders. All the functions and sub-functions embedded in the artefact correspond to the street traders’ daily bookkeeping needs. The bookkeeping application for street traders was designed to be simple, easy to use and to run in the Kiswahili language, which is the native language to many street traders in Tanzania. Most of the existing ICT applications for informal workers are too complex to be used in street trade and they run in a foreign language, particularly English, which is unpopular or unknown among street traders.

6.6 COMPARISON TO GRASSROOTS PROJECTS

Similar grassroots-level projects, in terms of the idea (record keeping), have been carried out by, for example, Wasilewska and Wong (2009), Talbot and Marsden (2011), Sharma and Johri (2014) and Palser (2011). However, the current thesis used a different approach, involved key stakeholders, took a research publications approach and focused its solution more on bookkeeping. There is a great deal of research on the challenges of street traders in Tanzania, and Africa in general, however none of the studies have used a design science approach to mitigate those challenges. Talbot and Gray (2011) researched a mobile handset-based stock ordering system to replace a paper system in South African microenterprises. Sharma and Johri (2014) presented a design-based research and implementation case for a financial literacy tool for rural dwellers in India. Wasilewska and Wong (2009) presented an idea for template applications for financial account books in Senegal. Giridher et al. (2009) showed a mo-
bile phone template application for account books based on goal-oriented accounting. Palser (2011) developed a mobile bookkeeping application for small and micro-enterprises in South Africa.

6.7 MOBILE FOR DEVELOPMENT

The number of mobile services has increased concurrently with the rate of mobile phone dispersion and usage in many African countries. The mobile phone revolution in Africa goes hand in hand with the designing and development of M4D interventions for social, cultural, economic, political and environmental challenges. This can be evidenced by the growing number of M4D projects, applications and programs that are designed for Africans. Currently in Tanzania, mobile phones are used the same as a digital wallet: to make and receive payments, pay utilities, and government taxes, access information, and serve as digital signatures for various occasions.

The increase in mobile based technology interventions provides an opportunity to improve productivity through better access to information, networking, and reduction of production and transactional costs. However, many M4D projects have achieved limited success in attaining their original goals. Some have failed either completely or partially, and others are continuing to collapse partly because of poor planning, implementing or evaluation (Toyama, 2010; Heeks, 2002). However, successful M4D projects, like mobile money, have created huge revolutions in financial inclusion, particularly for the poor (Rouse & Verhoef, 2016).

PIV of this thesis reviewed several M4D projects for informal workers in SSA. These include projects designed to mitigate informal workers’ challenges such as small-scale farming, business finance, record keeping, networking and education. The results show that information about the status, scalability, design process and impact of these projects in many cases is not shown. The projects’ websites and the published materials are silent about what the design processes are, the status of the projects (active/inactive), the current number of users and the general impact of the projects.

Some M4D projects with well-written publications, e.g., GSMA (2017a), are not accessible or working at all. This means that several M4D projects in SSA are phantom, and when they disappear, it is not recorded anywhere. Several of these projects have been designed without involving the potential stakeholders, hence the lack of ownership, which usually leads to low usage. Additionally, most of them have not considered the potential users’ characteristics, e.g., language, level of literacy, income, nature of business and culture. Most M4D solutions run on USSD, mobile apps, mobile web, SMS and voice calls, and most of them target small-scale farmers. M4D applications in SSA fall under the start-up category and are hindered by several setbacks, such as low uptake level, lack of localisation and uneven distribution.
among different categories of informal workers. These impediments make it difficult for M4D applications to sustain themselves to the growth and maturity stages.

In comparison to other M4D projects’ evaluation, little evidence has been presented on positive impacts. Some of the M4D projects, like mobile payment applications, (Kahn, 2013) have been integrated to offers various value added services, e.g., gaming, education, sports, entertainment, etc. In regard to agricultural information systems, most service innovations have not yet achieved a large scale and are in pilot stages. Furthermore, the research outputs are not objectively reported because 71% of the projects are funded by donors or governments who partner with mobile businesses, which creates a commercial confidentiality that blocks reliable evaluation (Denscombe, 2010). On the other hand, many of the currently available USSD/SMS-based services that mobile operators offer in developing countries are limited in service with exception of few. Despite of the weaknesses of USSD like costs associated, inflexibility, monopoly of the network service providers, need to memorize ussd codes, (Perrier, DeRenzi, & Anderson, 2015), it is still an important platform in Africa as many people are using ordinary mobile phones as compared with smartphones. The most well-known example of USSD in Africa is mobile money (M-PESA), which has made highest revolution in Africa by creating financial inclusion for the poor both in rural and urban places.
7 DISCUSSION OF THE RESULTS

7.1 INTERPRETATION OF THE RESULTS

This section provides discussions of the main results in Papers I, II, III and IV.

**PI.** PI answers the questions ‘What skills and strategies do street vendors need to succeed in their business environment?’ and ‘What are the street vendors’ perceptions on how to improve their success in street vending?’ The results show that most of the street traders do not have sufficient skills to do business. Currently they are doing business based on trial and error, use experience, and imitate from other traders. They do not have systematic strategies for marketing, customer management, bookkeeping, and business management. It is also difficult for street traders to access additional capital for upgrading their business. Street traders’ business management is very weak without proper planning, coordination, and evaluation of their business’ performance. Concerning business strategies, almost all street traders use similar business strategies, hence it is difficult to attain competitive advantages. In general, street trade is done by less educated people with few business skills, obtained through imitation from others and learning along with their own experience. These findings can be compared with Amoah-Mensah (2016) who revealed that street traders engage in multiple undifferentiated market strategies. It is common to find more than two street traders moving together with similar products, selling at the same price and applying the same advertising. They shout to everyone (using a loud speaker/bell) to buy their products, because they do not have a mechanism to identify their potential customers.

About improving street traders’ business, the findings show that street traders have a high interest in improving several areas, such as bookkeeping, marketing, and entrepreneurship. Largely informal workers in many African countries have rudimentary skills, hence a need for research to focus on skills development to increase productivity and earnings (Adams, Silva, & Setareh, 2013). In developing countries, skills development has been neglected. In Tanzania, for example, skills for street traders are not sufficiently promoted, either by governmental or non-governmental organisations. The government’s institutional system is fragmented, with no clear assignment of responsibilities for strengthening the informal sector (Adams, Silva, & Setareh, 2013). The available skills development schemes lack both technical and pedagogical effectiveness to fit street traders. Therefore, due to the lack of appropriate business skills, the traders cannot improve their business performance. Improving the productivity of informal businesses is critical for employment, income growth, and poverty reduction in the developing world.
PII. PII broadens the results of PI by using the exploratory sequential mixed methods research design to answer the research questions ‘What are the entrepreneurial needs, strengths, limitations, and types of work undertaken by street traders in Dar es Salaam?’ and ‘What technology innovation possibilities arise from the entrepreneurial needs, strengths, limitations, and types of work undertaken by street traders in Dar es Salaam?’ The findings show that many youth and women enter street trade because other employment opportunities are not available to them, due to low levels of education and insufficient capital to undertake formal occupations. Street traders work in difficult conditions involving walking tens of kilometres, working long hours, harassment from public and local authorities, insecurity, lack of necessary skills, and lack of technology for improving their business. Street traders’ profits are very low, though sufficient to cover the basic requirements like food, shelter, clothes, school fees and support for their dependents. Street traders have ambitions to upgrade and formalise their business, however they do not know how to do it.

Street vending is becoming more popular than formal business in poor countries because most of the poor urban migrants lack the education, skills, and financial resources to fit in the formal economy. In developing countries, it is more expensive to start a formal business compared to an informal business. In order to start a formal business one must have a premises (rent), working capital (higher than in street trade), business licence (licence fee), and initial tax, just to mention the more common expenses. Due to high initial formalisation costs, street traders opt to remain informal forever. This is in line with the legalist theory of informal economy, which views the informal sector as a way for micro-entrepreneurs to avoid the costs, time, and effort to formally register their business (Chen, 2007). Legalists hold that micro traders will continue to trade informally so long as legalizing a business is costly, in terms of time and money. Also, the school of thought known as voluntarism holds that informal enterprises choose to do their activities unofficially to avoid taxation, commercial regulations, electricity and rental fees, and other costs of operating formally (Boyle & Joham, 2013).

In regard to the possibilities for technology innovation arising from entrepreneurial needs, the results indicate a high potential for future DSR projects in many areas. These include a customer database to keep a record of customers (including demand, location, and contacts). The pricing advisory technology is needed to enable street traders to set a reasonable selling price. Additionally, a matchmaking application between customers, street traders and suppliers is important to reduce transportation and transactional costs. Street traders need a social network to facilitate communication, risk prevention and connection with potential customers. Other technological possibilities for improving street trade include weather information, information about supply, bookkeeping apps, educational apps, app to help street traders make business decisions, marketing, and strategic planning technologies.
ICT matters in street trade because it has the potential to facilitate trade by reducing transactional costs, providing up-to-date information, improving networking, bridging the skills gap, creating financial inclusion, and formalising businesses. The common challenges of street traders, e.g., lack of skills, financial exclusion, lack of market access, informality, and lack of business registration could be largely solved by ICT. However, many micro/small enterprises in Africa remain unable to fully utilize or upgrade their activities using the available ICT facilities (Murphy, Carmody, & Surborg, 2014). Except for mobile money, the use of ICT, particularly mobile phones, is largely embedded in existing relations of social support and conflict, hence its impact is minimal in terms of poverty reduction and business transformation (Carmody, 2013). Limited adoption of ICT by small businesses in Africa is caused by many factors, including poor designs that do not adhere to context-appropriate technology, socio-cultural factors, poor infrastructures, lack of participation with relevant stakeholders, services that do not meet local needs, and little consideration for the ecology of the users. These findings imply a need to design ICT artefacts that reflect the users’ characteristics.

PIII. PIII focuses on defining the street traders’ requirements and designing, demonstrating and evaluating the mobile application for the street traders’ bookkeeping. The central question in PIII is ‘How can an intercultural team co-create a bookkeeping application that is contextualised for Tanzanian street traders by following the principles of DSR?’ A team consisting of a software developer and a researcher, from Finland and Tanzania respectively, and street traders from Tanzania carried out a co-creation activity that resulted in a bookkeeping application for street traders. The activities included: 1) prototyping, getting familiar with each other, building trust, and setting the grounds for co-operation between the street traders, the project researchers and developers, and the local co-institution (CBE); 2) design and development continued the co-creation activities in the form of icon design, application development, and testing exercises; 3) the demo and evaluation stage consisted of a training workshop, testing, and evaluation meetings, continuing the trend of co-design within the project. This study has shown that DSR and co-creation are powerful tools that are fun to use, and they provide an endless number of exciting technology opportunities for joint DSR projects between technologists, researchers, designers, technology users and people from different countries and cultures.

The street traders were involved in all stages of design from problem explication to evaluation of the designed mobile application. User involvement is important in ICT4D because it yields an improved product quality arising from more accurate user requirements, production of the most relevant features with affordable costs, a high degree of acceptability, a better understanding of the system by the users, healthier decision making and effective use (Damodaran, 1996). On the other hand, inadequate or improper involvement of users in the design process is a major factor contributing
to ICT4D failure, particularly in developing countries. Paper IV of the current thesis found that many ICTs for informal workers in SSA have been designed with little or no input from the users, hence failing to deliver on the intended goal. Even if a participatory approach is used, many ICT projects in Africa fail because of differences in cultural settings and disciplinary matters (Winschiers, 2006). The current thesis proved Winschiers’ (2006) findings wrong, as people with different educational backgrounds, cultures, and limited resources successfully designed and developed a working application for street traders’ bookkeeping. The project is important because many ICT solutions in Africa are designed elsewhere and then sent to Africans without major modifications to fit the ecology of the user (Udo & Ifinedo, 2012). The current bookkeeping application for street traders was designed in Africa, with Africans, for the Africans.

**PIV.** PIV reviewed ICT for informal workers in SSA. PIV focused on two research questions: ‘What are the ICT projects designed for African informal workers?’ and ‘What challenges of the informal workers do these ICT projects solve?’. Many ICT projects have been initiated to empower the informal sector in Africa, however the ICT projects for farmers surpass projects for other types of informal occupations. The large number of ICT projects in small-scale farming is attributed to the importance of agriculture in Africa. Small-scale farming is a predominant occupation in SSA and employs most Africans. Despite their importance, small-scale farmers represent three-quarters of the hungry in Africa (Sanchez & Swaminathan, 2005) and form a large proportion of the world’s poor living on less than 2 USD a day. Another popular ICT for informal workers in SSA is mobile money. Mobile money is important to the informal sector because most of the informal workers do not have a bank account, hence they are financially excluded. Less than 30 percent of the population in East and Southern Africa has a formal bank account, ranging from 9 percent in Tanzania to 63 percent in South Africa (Aker & Mbiti, 2010). In Tanzania, Kenya, Madagascar, and Uganda there are more mobile money accounts than traditional bank accounts, hence mobile money is a bank for un-bankers.

This study also found several ICT projects for improving accounting and record keeping, networking informal workers through their respective supply chains. Social networks are important because they can connect traders via multiple networks with different information and opportunities for growth (Brüderlr & Preisendörfe, 1998). Social network support also increases the probability of survival, growth and sustainability for businesses. Educational technology is another area found to be affected by ICT. Most informal workers possess very low levels of education and skills. Inadequate levels of education, training and skills lead to poor business financing, marketing and management, which in turn lead to bankruptcy among small businesses (Boris & Reggie, 2012). Skills development is important for improving informal workers’ productivity and business sustainability.
ICT in Africa has helped informal workers overcome several challenges. In the case of small-scale farming, it has facilitated efficient information flow, networking farmers with key stakeholders, insurance, auction and marketplace information, weather updates, marketing information, farming management, disease prevention, education, record keeping, and advisory services. Mobile money enables informal workers to make safe savings deposits, access credit, get solar power/electricity, save time, earn interest on savings and manage their business effectively. Business finance apps allow informal workers to keep records of business transactions, access business education and manage their accounts in regard to financial management, financial reporting, cash management and financial decision making. Social networks enable informal workers to make connections with customers, suppliers, producers, markets, sellers and buyers to reduce business costs, increase customer satisfaction and provide wider access to business. Despite the importance of education for informal workers’ growth, we could identify only a limited number of technological solutions for educating informal workers. Through these applications, informal workers can write questions or problems experienced in their undertakings and send them to extension officers to get the answers. The existing solutions also offer informal workers possibilities to share their challenges and problems with their peers, and they can receive advice and suggestions on how to solve their problems.

The findings pointed out several weaknesses in the available ICT projects for informal workers in SSA. These include little use of user-centered design, uneven distribution of ICT projects in different types of informal activities and lack of information. In many cases, the information available about ICT projects for informal workers in SSA is lacking. For example, information about the design process, the actual number of users, active vs. inactive status and the general impact of the projects are not shown on the projects’ websites. In addition, most of the projects do not use a research based design approach and do not reflect users’ characteristics, e.g., level of education, income, available technology and literacy. For example, most of the record keeping applications are too technical and professional for informal workers to be able to access and use. In addition, the available educational ICT projects do not directly address the requirements of the informal workers. Informal workers need technological solutions that directly solve their constraints, are easy to use and affordable.

7.2 APPLICABILITY OF THE RESULTS

The findings of the current thesis have several implications. Firstly, they show the level of business skills and strategies of the street traders in Dar es Salaam. These findings are useful for the government, politicians and policy makers because they provide inputs for urban planning, empowerment and skills development programs.
The findings can be used to plan for skills empowerment for youth, to create strategies for empowering street traders and to implement various national policies, e.g., small and microenterprises’ development policies, trade policies, and national youth development policies. Furthermore, the findings relating to street traders’ activities are important to informal workers’ activists and politicians who fight for the rights of street traders. Secondly, the findings show the perceptions of the street traders on how to improve their success. This information is useful to anyone wishing to formalise or empower street traders. Lastly, the findings present the technological possibilities to address the difficulties of the street traders. These include the design and engineering of business applications that help street vendors automate important parts of their business and educational technology tools that help street vendors educate themselves. These findings are useful to technology practitioners, as they show what to design and develop for street traders.

PI has covered the first stages of a DSR project, including problem explication and requirement definition. Based on the presented results, a variety of threads for future projects can be initiated, where the DSR efforts move to more detailed requirement definition, design and development, demonstration and evaluation. In addition, the results of PII were used to design the first mobile application for street traders in PIII. PIII has shown that DSR and co-creation are powerful tools that are easy to use and can be applied to solve many problems in developing countries. The project in PIII has presented a mobile application for street traders’ bookkeeping. This application was developed to address the lack of record keeping observed in PI and PII. Through this application a street trader can record business transactions and see their business’ performance over a given period. Through this application, a street trader can also determine the appropriate prices for their products. PI and PII reported that most street traders can’t set a reasonable price for their products.

The results of PIV show that most informal workers are yet to benefit from the results of the recent technology diffusion in Africa. The results show that setbacks like low uptake level, lack of ICT contextualization and uneven distribution of ICT solutions among different categories of informal workers are the main challenges to this situation. These findings imply that entitlements like user-centered design and development, contextualisation, education for targeted users, creating awareness and building trust are important considerations. From these results, it follows that the designers and developers need to consider the ecosystem in which the applications ought to be employed when designing technology apps for informal workers.

The ICT ecosystem is “the policies, strategies, processes, information, technologies, applications and stakeholders that make up a technology environment for a country, government or an enterprise” (Kibere, 2016). The actors of ecosystem are the individuals who create, buy, sell, regulate, manage and use technology (Diga & May,
The designing and development of ICT4D should take into account social economic, political, spatial and other dynamics. The mode in which these ICT tools are designed, developed, and operate should consider the ecosystem of various players within systems (Diga & May, 2016). Different typologies of ICT ecosystems can be identified in many countries of the world in which there are disparities in social cultural, economic and political values. Poor consideration of the relevant ecosystems in designing and development of ICT4D is cited as cause of several project failure in the world (Toyama, 2010; Heeks, 2002). Informal workers have some different characteristics that may require special considerations when designing ICT interventions to improve their activities. Salient features of informal workers like low level of education, low income, informality, illegality, non-payment of tax, small capital, cash business, use of native languages and others may require special attention when digitalizing their activities. The participants (lecturers and street traders) in RPIII of the current thesis, insisted the need to consider the ecosystem of the street traders when designing mobile application for bookkeeping. The mobile application for street traders bookkeeping operate in Kiswahili, simple to use, contain the common transactions happen in street trade, can work in simple smartphone (e.g. TECNO Y3); to suit the ecosystem of the street traders.

7.3 RESEARCH CONTRIBUTION

DSR has two essential purposes (contributions). These are the contribution of the design artefact(s) into the problem environment and the contribution of new knowledge into the extant knowledge base (Hevner, March, Park, & Ram, 2004). The current thesis has explicitly planned and strived to achieve both purposes, that is contribution to artefact and knowledge outcomes. To elaborate these forms of contribution, Gregor and Hevner (2013) present a matrix with four quadrants (improvement, invention, routine design and exaptation) under the two dimensions: application domain maturity and solution maturity see Table 14. The current thesis falls under the category of the improvement quadrant. This is because many researchers have discovered several challenges of the street traders, however the use of ICT to come up with solutions contextualised to their environment is missing. According to Johannesson and Perjons (2014), improvements are the most common kind of design science contribution. In addition, this thesis has some elements of invention. This is because the use of smartphones to undertake bookkeeping in a street trade environment is new. Many street traders have mobile phones, however using them to facilitate business development is uncommon (Murphy, Carmody, & Surborg, 2014; Deen-Swarray, Mpho, & Christoph, 2013).
Table 14. Kinds of design science contributions adapted from Gregor and Hevner (2013).

<table>
<thead>
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<th>Solution maturity</th>
<th>Low</th>
<th>Improvement</th>
<th>Invention</th>
</tr>
</thead>
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<td></td>
<td>Develop new solutions for known problems</td>
<td></td>
<td>Invent new solutions for new problems</td>
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<tr>
<td>High</td>
<td>Routine design</td>
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<td>Exaptation</td>
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<tr>
<td></td>
<td>Apply known solutions for known problems</td>
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<td>Extend known solutions to new problems</td>
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<td></td>
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Effective design science research must provide contributions in the areas of design artefact, design construction knowledge and/or design evaluation knowledge (i.e., methodologies) (Hevner, March, Park, & Ram, 2004). The current thesis has two main contributions: the contribution of the design artefact into the problem environment and the contribution of new knowledge into the extant knowledge of street trading.

PIII presents the first working prototype of a bookkeeping application for street traders. The application enables street traders to record their daily business transactions and to see trade performance in terms of profit, cash flow and stock per given period. Also, the application enables street traders to set a reasonable selling price for their products. This application was designed to respond to the challenges of record keeping and lack of business skills among street traders established in PI and PII. The application was programmed in Kiswahili and corresponds to the ecology of street traders in terms of language, content and low level of education.

A well-written bookkeeping application allows street traders to make wise business decisions, measure business performance and access credit from formal financial institutions. This project is novel because the available existing applications were found not to respond directly to the needs of Tanzanian street traders. For example, most of the applications were either too confusing for street traders or not available in Kiswahili. In addition, an important reason for starting this project was co-creation. Thus, the larger goal of this project, beyond a single bookkeeping application, was to lay the groundwork for future DSR activities. In addition, building our own application could allow for the easy addition of new functions in the future.

Contributing to knowledge is the foremost criterion for published research. Contributions to knowledge can be comprised of partial theory, incomplete theory or even some particularly interesting and perhaps surprising empirical generalisation (Gregor & Hevner, 2013). The current thesis presents the street traders’ skills and
strategies that apply to their daily business activities. It shows how street traders perform product selection, pricing, distribution, promotion, after-sale services, management, bookkeeping and other business activities. This thesis shows the strengths, weaknesses and practices of street traders in Dar es Salaam, Tanzania. This is the first study that identifies street traders’ business skills, activities and strategies that can be addressed with technology. A variety of technology innovations are proposed to directly address the daily challenges of street traders. It provides an opportunity for future technology projects and forms exciting new possibilities for technology experts, students and scholars both in developed and developing countries. The expected future implications of this project are increased science technology and innovation capacities, economic growth and human development. Furthermore, this thesis has contributed to the knowledge on the state of technology for informal workers and shows the areas of weakness that need to be studied by future researchers.

Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies (Hevner, March, Park, & Ram, 2004). Much of the available research contributes in artifact, design foundations and little in design methodologies. The current thesis has contributed to the design methodologies in different ways. First, it has shown that, the use of intercultural team is important in DSR because it brings together diversity of skills, knowledge, experience and resources necessary to produce effective artifact. Less developed countries like Tanzania lack ICT experts who can design and develop effective ICT tools to overcome the challenges of its people. Second, the experience obtained from DSR activities done in this thesis suggest that, considering the users’ ecosystems is a very important step toward designing and developing successful ICT artifacts. Street trade is quite different from other formal businesses in several ways, which include cash management, tax, size of business, capital invested, working hours, business risks, relationship with government authorities and so on. All these features need to be considered when designing an ICT application for improving street business. Therefore, there in a need to incorporate the issue of ecosystem in initial stages of DSR framework. This is important because, it will result in designing and development of ICT artifacts contextualized with users’ environment.

7.4 LIMITATIONS OF THE STUDY

The respondents for PI and PII were obtained from Dar es Salaam, and those for PIII from Dodoma, though street traders are found in all regions of Tanzania. The assumption is that Dar es Salaam and Dodoma are true representatives of all cities in Tanzania, something that needs to be proved by a comparative analysis of the street traders among all cities in Tanzania. However, future research should increase the
sample size and collect data from multiple countries to analyse the similarities of the street traders’ challenges. The research limited respondents to the ages of 18–35 and included only mobile street traders. Further research may focus on broader age categories and additional forms of street traders, e.g., stationary street traders. This group may have special needs or characteristics not covered in the current thesis.

Although PI and PII identified various limitations of street trade in Tanzania, PIII addressed only one challenge (record keeping). The proposal for future researchers is the initiation of software teams to work on the remainder of the technology solutions proposed in this thesis, including upgrading this prototype to a full application.

The evaluation of the artefact provides feedback and a better understanding of the problem to improve both the quality of the product and the design process. In this thesis, the conducted evaluations remain somewhere in between naturalistic evaluation (artefact is evaluated in real practice) and artificial evaluation (artefact is evaluated in an artificial setting). Some of the features were evaluated in a classroom environment, while some functionality was evaluated while the end-users were conducting their actual business activities by using the artefact. However, these evaluations are relatively simple, and there are no rigorous quantitative evaluation criteria or mathematical analyses that would prove the effectiveness of the application or the underlying design process employed. Thus, most of the evaluation results are qualitative. Qualitative results are rarely generalisable but provide insights and new ideas about previously unknown issues (Creswell, 2014).

PIV has some limitations, which include a lack of complete information about the ICT projects for informal workers. For example, the status of the project—that is, whether active or inactive, the number of users and its current impact were unavailable. In addition, the informal sector covers a wide range of labour market activities; however, this thesis focused on the major types of informal workers, namely small-scale farming and small/micro informal businesses. This project did not include construction, manufacturing and service based informal working occupations due to time limitations and lack of information. The project includes only the ICT solutions that can be accessed through the internet; however, there is a possibility of including other projects that have not yet been published on websites. Lastly, this was a desk research study and did not include primary data collected directly from the ICT designers, users and other stakeholders.

7.5 FUTURE SUGGESTIONS

One important direction for future research and development is to find the best ways to upgrade street traders from informal to formal businesses by using ICT. This is important because many challenges affecting street traders in Tanzania, e.g., illegality, access to finance, and products confiscations emanate from the informality. The formalisation of street vending businesses has been addressed by many researchers
including Lyons (2013), Tonda and Thembela (2016) and Rogerson (2016), however none of them have looked at it through the lens of ICT. Formalisation barriers like cost, bureaucracy, willingness and complicated procedures have prevented many micro and small firms from formalising, thereby hindering the national income in poor countries (Rakowski, 1994). On the other hand, informal workers around the world have ICT devices such as mobile phones and use them largely for peer communication and money remittance and little in the formalisation of their business. Again, research (Garcia-Murillo & Velez-Ospina, 2017) has pointed out the power of ICT in transforming the informal sector. However, there is a lack of research on how to use ICT in formalising the informal economy.

The current thesis has opened a new avenue for research, development, and entrepreneurial opportunities around education and technology for street vendors. Future research tracks might also include the study of product flows, supply chains, trader, and wholesaler hierarchies and a more thorough categorisation of street traders based on different product groups, success profiles, and life stories of street traders. Another idea for further research is to analyse the intensity of business over a period of work. For example, how much of an 18-hour workday is idle time, and what are the peak hours for profit making. The identification and further analysis of the business strategies of the most successful street traders is one important future research direction. The results from these future studies would extend and complement previous studies and increase understanding of the benefits of DSR projects.

Another important area is the initiation of software teams to work on a variety of topics, including applications for street traders. These teams could be initiated by companies, universities or technology hubs. Co-design activities should also be brought into the information technology curriculums of higher education institutions in developing countries. The review of technologies for informal workers can be extended in future research by collecting primary data related to the ICT projects and initiatives to complement the literature review presented. For example, interview data could be gathered from the ICT designers, developers, and the targeted users to find out their perceptions toward the presented solutions. The literature review did not evaluate any solutions or strategies to overcome the challenges. Thus, future research could focus on this aspect. Future research could also compare ICT projects in formal and informal firms to unveil further lessons that may be helpful for further research and development. Similarly, future researchers may study the various design processes of the ICT solutions for informal workers.

The street traders participated in the design process may not continue to use the application after the test period. There may be several reasons for this. First, the traders may not see the benefit versus the added inconvenience of adding the business transactions to the system, as compared to business-as-usual (without keeping records). Indeed, the project may not have given enough incentive for the application usage in terms of clearly demonstrating how using such an application
would, in the longer term, be beneficial for business. Therefore, to demonstrate business benefits, must remain as a topic for future research.

The evaluation shows that the developed artefact has now provided a means to do record keeping. However, this does not necessarily imply that the street traders would have the motivation to do so. In regard to the lack of motivation, several reasons may exist. Assumptions as to lack of motivation could include, for example, 1) suspicions about taxation activities subjected to traders if records were kept, 2) lack of seeing the long-term benefits versus the short-term inconvenience of using the application, 3) the traders would rather use the mobile phones to do other things. The information system developers need to understand the behavioral intention that ultimately lead to system usage (Jackson, Chow, & Leitch, 1997). To achieve these objective various theoretical perspectives e.g. Technology Acceptance Model (Davis, 1989), Theory of Reasoned Action (Fishbein & Ajzen, 2010), Innovation Diffusion Theory (Rogers, 1983), Expectation-Confirmation Model in Information Technology Domain (Brown, Venkatesh, & Goyal, 2011) and others have been advanced (Jackson, Chow, & Leitch, 1997). The future research may use these theoretical perspectives to predict street traders’ intention to use the app.

7.6 CONCLUSION

Street trade is an important economic opportunity for the less educated and poor in developing countries. Through street trade millions of youth and women can secure employment, income and help with the distribution of low-priced goods. Although the individual profits for street traders is low, cumulatively they contribute significantly to the GDP. Basing on the evidence from the drivers of the informal economy, street trade will continue to mushroom in low income countries, therefore immediate intercession in their business challenges is called for. Even though street trade is an opportunity for generating reasonable income for many people, most traders operate in a challenging environment, and they do not have a way to improve their endeavours. Despite much research on street trade there is a paucity of knowledge about how street traders conduct business in terms of business skills, strategies, and the use of technology to improve their undertakings. Most of the available literature on street trade focuses on the socioeconomic aspects and the challenges street traders encounter and little on empowerment, particularly through ICT. Removing barriers for street traders’ productivity through technology is needed in order to enable street vending to work effectively for poverty reduction and economic growth.

The diffusion of mobile phones provides Africans with a unique opportunity to transform their socio-economic activities. However, the mobile phone itself is not a panacea to cure all African challenges without entitlements. Entitlements like user involvement to design mobile phone products that are contextualised within African ecology are needed to garner the opportunities of new mobile phone technologies.
The current thesis used a design science research approach to understand street traders’ strategies and activities, identify the gaps and design a mobile application to mitigate the bookkeeping problem. This thesis is relevant because Africans need to improve their capacity to use science and technology and more efforts must be put into research and development to benefit them (Trojer, Rydhagen, & Kjellqvistt, 2014).

The main research interest of the present study is to improve street traders’ business through appropriate mobile application for record keeping. The findings show that street vendors operate in a challenging environment and possess low levels of business skills in all domains of business and make most of their decisions based on tacit knowledge. Traders are restrained by unreliable business information, weak business strategies, lack of access to capital, and lack of record keeping knowledge and opportunities. This thesis resulted in the successful design, development, and demonstration of the first version of a bookkeeping application for street traders, which is ready for further DSR projects. The findings suggest the possibility of inter-cultural co-creation activities using limited resources. In addition, the findings show a low level of ICT uptake by informal workers, scarce use of user-centered design principles, lack of design science research approaches, and uneven distribution of ICT solutions among different types of informal workers. The current study has shown that it is possible to use DSR to empower marginalised members of society like street traders.

To my knowledge, this is the first study in Dar es Salaam that has used a design science research approach in order to directly address street traders’ daily challenges with technology. This research has opened a new avenue for research, development and entrepreneurial opportunities in the areas of education and technology for street traders. The wider impact of this project extends to economic growth, human development, increased STI (science, technology, and innovation) capacities, and an increased number of exciting technology opportunities for joint technology projects between researchers from developed and developing countries.
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NASIBU RAJABU MRAMBA

The ubiquitous and pervasiveness of mobile devices is transforming business performance in the world. This book explores the activities, strategies, business skills of street traders in Tanzania and developed a mobile application to overcome bookkeeping challenge. The designed app enables street traders to fix reasonable selling prices, evaluate cash and stock flow, prepare profit and loss reports, make informed business decision, and access various supportive services. Additionally, this book offered several future technology tracks to improve street traders’ business.