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ICT for Informal Workers in Sub-Saharan Africa: Systematic Review and Analysis

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Abstract—In Africa, wide diffusion of Information and Communication Technology (ICT), particularly mobile phones and Internet technology, has opened new opportunities for informal workers. New opportunities include better access to information, improved welfare, reduction of search and transaction costs, and improved competitiveness. Despite these opportunities, there is limited scientific knowledge about the available technologies applied in the informal economic sector in Africa. In this research, we reviewed recent ICT projects and initiatives designed for informal economy in Sub-Saharan Africa through the lens of design philosophies, applied technology, and the services offered. Our findings show 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 informal workers. We recommend the software developers to strive towards implementing ICT solutions that are designed based on the real-life challenges faced by informal workers.

Keywords—ICT; Informal workers; informal economy; Sub-Saharan Africa

I. INTRODUCTION
Informal economy refers to the unregistered, unregulated, and un-taxed, but otherwise legal businesses, including those in the service and production sectors [1]. In Sub-Saharan Africa (SSA), the informal sector constituted from roughly 50% to 75% of non-agricultural employment, and 30% to 60% of gross national products (GNP) in 2000s [2]. The continuous rise of the informal sector in Africa is attributed to women’s marginalization, economic hardship, poverty, weak government support, and demand of low cost products and services. Although the informal workers continue to be the main source of income and employment in the developing countries, they often suffer from weak marketing and business networking, lack of-, or inadequate business skills, lack of access to finance and undeclared legal status [3]. Information and Communication Technology (ICT) researchers have demonstrated the potential of ICT in solving informal workers’ challenges, which may create opportunities to lift a society from the bottom to the top by stimulating economic development and reducing poverty [4]. The main motivation to investigate the use of ICT within the informal economic sector in SSA is that there is limited scientific knowledge available about what kind of technologies are being used and developed for informal workers. Thus, the purpose of this work is to review the recent ICT projects and initiatives targeted for informal workers.

II. METHODOLOGY
We performed a systematic literature review study on ICT projects in SSA related to informal economy. The purpose is to find out what can be learned from the experiences of developing ICT solutions for informal workers in SSA by summarizing and synthesizing what is known about practical implementation of ICT solutions. This research aims to contribute to the body of knowledge related to the use and development of ICT for informal working in SSA. A practical outcome of the study is to inform the ongoing doctoral business computing research studies conducted at College of Business Education (CBE), Tanzania, related to informal business, such as street vendors. We have followed the quality recommendations given by [6] when conducting the literature review. This review is based on a specified research strategy, with the aim of detecting as much of the relevant literature as possible. We have set explicit inclusion and exclusion criteria for selecting the articles.

A. Research Questions
This research was guided by the following research questions; 1) What are the ICT projects designed for SSA informal workers? 2) What challenges of the informal workers do these ICT projects solve?

B. Sources of Data
Three sources of data were used in this research: 1) scholarly articles, 2) ICT4D conference websites, and 3) project specific websites. The scholarly articles were obtained through searching from the scholarly portals including IEEE, and ACM. The open access articles were accessed through search engines specifically Google Scholar, Google Search Engine and Google Books. Also, data was obtained from African based ICT4D conferences, such as ICT4Ag-conference, International Conference on Mobile Communication for Development, Mobile 360 - Africa, and IST-Africa. After getting to know the projects from the identified scholarly articles and conference proceedings, we accessed the project websites to explore more information about the projects.

C. Search Keywords
The following set of keywords were used to search ICT applications for informal workers as described in the previous section; (ICT OR "mobile technology" OR "software" OR "Mobile Application" OR technology) AND ("informal
In Africa at the end of the first decade of the 21st century [7]. After the huge diffusions of mobile phones in Sub-Saharan between 2007 and 2016, since most of the ICT projects came after the huge diffusions of mobile phones in Sub-Saharan Africa at the end of the first decade of the 21st century [7].

D. Inclusion and Exclusion Criteria
In our analysis, we included ICT projects that were being in use between 2007 and 2016, since most of the ICT projects came after the huge diffusions of mobile phones in Sub-Saharan Africa at the end of the first decade of the 21st century [7].

III. RESULTS: OVERVIEW
This research reviewed various aspects of the ICT projects for the informal workers in SSA. These include; the design philosophy, technology channel, and the solutions offered to informal workers.

In regards of the design philosophy, the results show that out of 45 ICT projects identified in this review, 11 are design science based, 1 is living lab, 2 are action research, 1 is dialogic design and 30 are silent (no information). About the technology channel, out of 48 ICT solutions of the informal workers’ challenges, 11 run on Mobile app, 8 on Unstructured Supplementary Service Data (USSD), 17 on SMS, 6 on voice call, 22 on Website, 2 on Radio, and 1 on Television.

About the solution offered to the informal workers the result show that most of the services focus on small scale farmers’ challenges, including market access, farming education, whether conditions, and farm management, mobile money, business finance, networking, and education.

In regards of small scale farmers, the review has found many ICT projects to overcome their challenges. These have been categorized to market and marketing information (8 projects), education (6 projects), records keeping (4 projects) veterinary care and medications (4 projects), insurance services (3 projects) and weather information (2 projects). In regards of mobile money, the informal workers can save and withdraw money, send and receive money, access loan and solar power, earn interest on saving and reduce transactional costs. About business finance, altogether six (6) technological projects carried in SSA were found to be related to business finance. These projects allow the informal workers to do bookkeeping, financial recording, and accounting.

This review identified two categories of ICT applications for informal workers networking; linking informal workers’ activities, and access to information. In addition, this review has identified four (4) technological projects related to business education for informal workers in SSA.

IV. RESULTS AND DISCUSSION
A. Design Approach
We reviewed various design approaches used to develop ICT solutions for the informal workers in SSA. The information about how most of these ICT solutions are designed is, however, missing. The designers do not explain the process passed through when designing their ICT solutions. However, most of the designers discuss the motives that drive them to design such solutions, mostly the challenges facing their society. Also, we observed the gap between the ICT solutions and the informal workers’ characteristics. This is in line with [8], who observed a mismatch between the designs and local users’ reality in many ICT4D projects in developing world. The greater inclusion of stakeholders in the design with formal mechanisms for feedback leads to success of a project [9]. Likewise, we observed only few ICT solutions designed through design science, user centered and living lab approaches. Thus, an evident recommendation for future research is to investigate how the ICT solutions have been designed and developed, and suggest design principles to guide the future design efforts.

B. Technology Channel
The rapid growth of ICT in the world has had the potentials of transforming the informal workers’ sector by increasing growth, competitiveness and sustainability through better market access, cost reduction and wider business opportunities. Notwithstanding the fact that many technologies are available in the market, mobile phone has been a popular tool used by informal workers in Africa [10]. The choice of mobile phone is attributed by affordability, availability, lower costs, and wide access [10]. There is no technology that has ever spread faster around Africa than the mobile phone, providing opportunities for social economic development [11]. The findings show that many ICT solutions for the informal workers run on mobile phones. These are USSD, mobile apps, mobile web, SMS, and voice calls. Our findings support the previous research, which found the popularity of mobile phones among Africans [11]. 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.

C. ICT solutions for the Informal Workers
1) Small scale farmers
Our study showed that several applications have been designed to empower small scale farmers in Africa. These have been categorized to market and marketing information [14, 15, 16, 17, 18, 19, 20, 21], education [22, 23, 24, 25, 26, 27], record keeping [28, 29, 30, 31], veterinary care and medications [32, 33, 34, 35], insurance services [36, 37, 38], and weather information [39, 21]. The identified ICT projects to small scale farming use a variety of technological solutions such SMS.

1 One application can run in more than one technology channel. For example [22] run in web, radio, and mobile app
mobile apps, website, solar power, USSD, FM radio, fax, voice calls, cloud computing, television, and internet. The developed technologies have improved the performance of small scale farmers through efficient information flow, networking farmers with key stakeholders, insurance, auction, market place, weather updates, marketing information, farming management, diseases prevention, education, record keeping, and advisory services. However, we were not able to find evidence about the adoption of ICT projects among small scale farmers.

2) Mobile money
Mobile money is a SMS or smartphone based application that allows the user to deposit, send, withdraw, and make various payment transactions through a mobile phone [40]. More than 52% of mobile money users in the world are found in SSA. Ivory Coast, Somalia, Tanzania, Uganda and Zimbabwe have more mobile money accounts than bank accounts [41]. The general idea of mobile money was to have financial inclusion of people with access to mobile phones [42, 40, 43, 44]. Our findings show several mobile money services relevant to the informal workers. These include savings, remittances, credit, solar power, and payments of utilities.

These services are important because the bank saving behavior is erratic in many African countries. In Tanzania, Ethiopia, and Nigeria, less than 11% of the population are bank account holders, which makes saving money unsafe [10]. The findings suggest, that despite the importance of mobile money, the costs associated with it are an obstacle to small and micro informal businesses. Similarly, the credit and loan offered by mobile money companies needs to be repaid within a very short period (one month), which is a risk to informal workers, particularly when the production requires more than one month. Also, most of the available mobile money platforms have text based interfaces, which means that illiterate users (majority of the informal workers) can’t use them well.

3) Business finance

Business finance is the art and science of managing the financial resources of a business [45]. It is concerned with proper and efficient allocation of resources to attain business vision (growth, stability, profitability, cash flow). Several studies show that poor, careless or weak business finance management causes business failures [46]. The informal workers lack a systematic structures, procedures, and strategies for business finance [72]. Their financial plan, monitoring and evaluation, are done intuitively and can’t be used to access credit from formal financial institutions [3]. The identified ICT solutions for the informal workers’ business finance allow the users to keep records of business finance, get business education, accounting, financial management, financial reporting, cash management, and financial decisions [47, 48, 49, 50, 51, 52]. These applications have an opportunity to overcome the challenges of poor record keeping that is common among the informal workers [3].

4) Business networking
Connecting business components and sub components with internal and external stakeholders, for example, customers, transporters, and input suppliers is a necessary condition for achieving competitive advantages. A well-coordinated and connected business process reduces costs, increases customer satisfaction, ensures a constant balance between demand and supply, and increases profitability of the business [53].

The entrepreneurial networks in small firms offer important resources in which most of them are lacking. These resources are important to enhance firms’ performance and sustainability [73]. Importantly, the networks are the primary source of business information in an enterprise [74]. In our study, we found several ICT projects for improving business networks between informal workers and their key stakeholders such as customers [54, 55, 56, 57, 58]. The identified applications allow the informal workers to make connections with customers, suppliers, producers, markets, sellers, and buyers to reduce business costs, increase customer satisfaction, and provide wider business access. Our finding show that most of the business finance applications run on SMS, website, smartphone and mapping technologies.

5) Educational solution
The failure of small business is often caused by lack of entrepreneurial knowledge and business management skills [64]. Inadequate level of education, training, and skills leads to poor business finance, marketing and management, which in turn leads to bankruptcy among small businesses [65]. Despite the importance of skills, informal workers do not have adequate skills and professional expertise to undertake their work profitably [66]. Our previous study [67] has recommended the designing and development of education technology artifacts to educate informal workers (street traders) on basic business skills and strategies. Our findings show that, the informal workers get education via SMS, digital storytelling, e-novel, and social networks [68], [69], [70], [71]. Through these applications, the 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 advices and suggestions how to solve their problems. We argue that more education interventions are needed to enable informal workers to perform their economic activities competitively.

D. Observations from the Results

1) About the surprising results
We found a surprisingly very few projects in the domains of education, financial management, and access to finance. Another surprising result is the large number of mobile applications in the agricultural sector. We noted that lot of ICT solutions have been developed especially for small scale farmers in Kenya. We are not able to explain why agriculture in Kenya is so popular area for ICT innovations.
2) About the informal worker’s challenges solved
Despite the huge ICT diffusion in Africa, the degree of uptake is not promising. Most of the ICT projects focus on the informal workers’ business challenges that emerged after production, and ignore the other side of the supply chain, for example, decision about what, how and where to invest. Likewise, majority of the available ICT projects do not consider characteristics and peculiarities of informal workers, such as income, education, attitudes, knowledge, and perception. In addition, most of the identified ICT projects are not directly addressing the requirements, which carter for the needs of informal workers.

3) Observation about the identified research gaps
Based on our study, we can pinpoint several areas that need further investigation, such as promotion of ICT adoption and usage in the informal undertakings, development of user centered design methods, and evaluation of the impact of the existing ICT solutions. Additionally, we noted a need for developing ICT solutions for entrepreneurship skills and business education, which are insignificantly tackled by the existing ICT solutions. It is also important to investigate and develop contextualized strategies for scaling up the existing ICT solutions to fully fledged products. We also recommend for the ICT designers to develop solutions for other types of the informal sector, beyond small scale farmers. Finally, we recommend more extensive use of design science research practices via proper application of data collection and empirical analysis techniques

4) Observation about the design and evaluation aspects
The goal of designing is to produce artifacts that can address real world or business challenges [75]. Based on our review, we claim that most of the identified ICT solutions for informal workers were designed because the designers either experienced a problem or saw an opportunity of making profit. We also noticed that most of the ICT solutions for the informal workers were developed without following principles and theories of user centered design. We therefore recommend for the upcoming researcher to adhere to design principles. We want to stress that the design and development of ICT solutions for the informal workers should arise from the challenges experienced by the informal workers in their daily activities, within their local environments. Greater inclusion of the users and other stakeholders leads to greater success of ICT projects than excluding them [9].

E. Limitations of the Study
The limitations of our study are the following. First, during the review process we were not able to find all information about the ICT projects and initiatives for informal workers. For example, in several cases we were not able to find information about the status of the project (active or inactive), the number of users, and the current impact of the solution. Second, we narrowed our focus to include only major types of informal workers, that is, small scale farming and micro businesses. Third, we included only those projects that can be accessed through Internet. Thus, there is a possibility that other projects exist, which have not yet been published on websites. Lastly, we did not include primary data collected directly from the ICT designers, users and other stakeholders to triangulate the findings with other research data related to the topic.

V. CONCLUSIONS AND FUTURE RESEARCH AGENDA
In many cases the informal sector is the only opportunity available for poor Africans to make them survive. However, the daily activities of informal workers are constrained with many challenges, and therefore they often fail to achieve optimal performance. In this study, we analyzed several new ICT based solutions to address the challenges of informal workers. The identified solutions for informal workers ranged from business networking, education, business, and finance. We found several setbacks related to the adoption of ICT among informal workers, such as low uptake level, lack of ICT contextualization, and uneven distribution of ICT solutions among different categories of the informal workers. We concluded that majority of the informal workers are yet to exploit the opportunities offered by ICT to improve their undertakings.

The findings suggest that the diffusion of ICTs may not necessarily lead to development unless other entitlements are provided. We are recommending the following entitlements to be used when designing and developing ICT solutions for informal workers in any content: (1) involvement of users’ centered design and development, (2) contextualization of the solutions, (3) providing education to targeted users, (4) creating awareness and building trust among the users of the technology. The designers and developers need to consider the ecosystem in which the applications ought to be employed. We hold that with properly designed ICT solutions the informal workers can revolutionize their social economic activities leading to economic development.

Our study can be extended in future by collecting primary data related to the ICT projects and initiatives to complement the literature review we 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. In our review, we did not evaluate any solutions or strategies to overcome the challenges. Thus, the future research could focus on this aspect. The 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, the future study may study the various design process of the ICT solutions for the informal workers.
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