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Importance of Participant Characteristics in Software Systems Design In the Informal Sector

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ABSTRACT

The early research involving mobile phone applications software design for the poor used the general pervasiveness of mobile phones as the major justifications for their design decisions. Other factors such as the economic levels, demographics and even the actual ownership and type of mobile phones received less emphasis. Recently, researchers have shown that good software design decisions must be informed by among other things, the special user characteristics. In this paper, we show that the overall software design decisions for the informal sector, a case of the semi-literate, semi-skilled and unskilled day-labourers, were better off informed by the various important user characteristics than the mobile phone pervasiveness only. The key objective of the research was to inform the kind of ICT design to help the day-labour market alleviate some of their day-to-day challenges. Results indicate that, while the high statistics of the mobile phone pervasiveness among the poor are a determining factor on whether to build mobile phone software applications, education level; social factors; needs knowhow; income and expenditure; ownership and use of technology and type of mobile phones can also be part of the main determining factors. In this study, against our expectations, demographics proved to be irrelevant when it comes to software design decisions. Further, we found that over 95% of all those who went to school up to grade eight and above own mobile phones while 10% of those below grade five owned mobile phones. We interpreted this to mean that mobile phone ownership and use have a direct correlation with education level. Therefore, education levels, and hence, literacy levels of the target users are important design implications from the point of view of needs assessment and requirements elicitation.

Keywords: Day-labour, mobile phone, mobile applications, Post disaster mitigation, MANET, Mobility model, AODV, OLSR, ZRP, RPGM..

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1. INTRODUCTION

The mobile phone has been regarded as the computer of the developing world. It has been targeted by a majority of Information and Communication Technology for Development (ICT4D) researchers and practitioners whose objective is to develop Information and Communication Technology (ICT) systems to help the poor alleviate some of their challenges. However, such interventions using the mobile phones and targeting the poor have had many challenges, leading to unsuccessful initiatives [1]. In many initiatives, the assumption has been that systems could easily be designed to take advantage of the pervasive nature of the mobile phone in the developing world. For example, [2] and [3] have indicated that many entities with global development focus have turned to mobile phones as a potential platform for delivering development services. Further, existing research on mobile phone adoption focuses mostly on a specific aspect of technology adoption [4]. Such studies tend to take into consideration feature-driven and usability perspectives and ignore the alternative or wider perspective i.e. the demographic, social, cultural, and contextual factors [5]. In the recent past, studies such as that by [6], involving systems design, have shown that it is not only enough to use technology pervasiveness to make design decisions. As a result, they have considered various characteristics which include the demographics, education levels and the income and expenditure of the target users, therefore moving away from the old way of overemphasis on the pervasiveness and making assumptions about the details of the special user characteristics. Indeed, studies on adoption of mobile phones have shown that social influence is very important [7] and that influences on adoption do not predict long-term use [8]. Therefore, there is need to consider the wider perspective when designing mobile phone applications for the disadvantaged. In keeping with this latest trend, our study took cognizance of the need to consider any special user characteristics without making any assumptions on the pervasiveness of the mobile phone among the poor.

This, in any way, does not exclude the importance of mobile phone pervasiveness in design decision making for the day-labour workers. In our work to find out the kind of ICT design to help the Day-Labour Markets (DLMs) alleviate some of their day-to-day challenges, we discovered that software design decisions for the DLMs were better off dictated by various factors and user characteristics which were important to ICT interventions among the DLM stakeholders. This paper therefore describes the user characteristics which were important in making design decisions for the informal sector, a case study of semi-literate, semi-skilled or unskilled day-labourers. It also shows, by description, how such characteristics influenced our decisions with regard to systems design to help the poor. The software systems design processes; the actual systems and evaluations that resulted in the work described in this paper are presented elsewhere [9]; [12]. As a result, the major contributions of this work include the study process (methodology) and the characteristics which could be used to make design decisions in an informal sector (described at the results and the discussions sections).

In arguing that the pervasive nature of the mobile phone has been used as a major justification for using the mobile phone/hand-held devices as the computing device in the developing world, we do not in any way indicate that it is not a part of justification for this study. In fact, the argument is, apart from the mobile device pervasiveness, there are other factors that need to be considered when designing for the unskilled low-illiterate users. The rest of the paper is organised as follows: Section two presents the background information and the problem definition. Related work is presented in Section three. Section four is the study process while Section five presents the results (the user characteristics). The design decision discussions are presented in Section six while the conclusion is presented in Section seven.

1.1. Background Information

The context of the study, some of whose results are being presented in this paper, was ICTs and the informal sector, a case of the DLM. The case study areas were Cape Town and Johannesburg, South Africa; Nairobi Kenya and Windhoek Namibia. In this section, we contextualize the study by describing the DLM and ICTs.

1.2 The Day Labour Market and ICTs

In many of the discussions about the use of ICTs in the developing world, one salient theme is that appropriate conceptualisation of ICTs can aid in poverty reduction [42] in different ways [13]; [14]; [15]. Poverty levels which can be reduced by ICTs can be found among the non-skilled, low-skilled, illiterate or semi-literate workers whose contracts are on a daily basis. The workers, also referred to as day-labourers, are mainly job-seekers when out of work. They belong to an informal sector referred to as the DLM [16]. The DLM is made up of the day-labourers, the DLM employers and, optionally, organisations which help in running the DLM by organising workers and employers. A DLM organisation can either be an independent non-governmental organisation (NGO) (DLM intermediary organisation), or formed by the DLM workers themselves (self-organised DLM). These organisations manage the worker collection points, which are locations where the day-labourers congregate to wait for potential employers to pick them up.

In conceptualising our problem, the key aim was to find out the role of ICTs in helping to alleviate some of the challenges faced by the DLM by linking the job-seekers and the potential employers using existing and affordable ICTs. At the same time, the objective was to have the intermediary organisations utilise ICTs to serve the workers and employers efficiently. In our study, literature review and the field study findings revealed that the ICTs that were mostly available, viable and affordable were the mobile phones and web-based technologies, which led us to consider them for solving some of the DLM challenges.

1.3 The Problem Statement

Different groups of the poor inhabit the urban areas [17]. Using a case of the DLM, we found that these poor urban inhabitants bear the greatest negative impacts caused by the infrastructural challenges. Among the poor are the unskilled or semi-skilled (low-skilled) DLM job-seekers. Their commuting activities are affected by the notorious congested cities facing many hours of gridlock during peak hours. The day-labour workers are continually looking for employment and hence can be classified as unemployed. Even when they are employed, they might not be the following day and hence are continually faced with the problems of being unemployed. As a result, they have very low income, which is not always enough to cover for their daily expenditure [18]. Continual job search is also the nature of the DLM; it is one in which an excess supply of job-seekers compete for relatively few jobs [43]. Each day, a day-labourer commutes to work or to a certain destination in search of work. When travelling to look for work, a day-labourer will be spending money which they can ill afford because during their working periods, they do not earn enough to allow them to save any. For example, in our field work study, we found that many day-labourers use a substantial amount of their income and time looking for jobs [9]. We also found that the day-labourers spent up to 10% of their daily income in job-related expenses, such as daily transport costs, even when they are not commuting to work.

When out of work, job-seekers are sometimes forced to wait at the collection points during harsh weather conditions. Other challenges faced by the DLM workers include the lack of proper ways of organising themselves in the absence of an NGO. More often, because job-seekers are eager to secure a job, they tend to approach the potential employers *en mass*, an act which usually intimidates potential employers, especially if it is their first time visiting the collection point. These DLM challenges associated with the operation model of the DLM leave the day-labourers jobless and confined to extreme poverty [19]; [20]; [21]. It is some of these challenges that we were trying to use ICTs to alleviate.

2. RELATED WORK

Our literature search on similar arguments as ours did not yield much closely related work. However, a few studies showed that there have been attempts in this area albeit with limited breadth but in depth on specific issues. For instance, work by [6] looked at illiteracy when designing job search and a generic map system for a community of illiterate domestic labourers. The specific objective for [6] was to come up with a user interface for illiterate or semiliterate users. Following the same objective of designing for the illiterate, [11], implemented a paper-based system that provides the intended functionality of helping match low-income domestic workers from an urban slum with potential middle-class employers in Bangalore, India. Similarly, a study by [22], which reported work to compare semi-illiterate and illiterate users in system design narrowed down on one user characteristic (literacy). The study showed the need to treat semi-literate users differently from illiterate users in the interface design.

In another illiteracy-related initiative, [18] presented the *VoiAvatar* artifact for use by micro-businessmen to make virtual avatars by making phone calls. The *VoiAvatar* objective was to avoid locking out illiterate users. The *VoiKiosk* system [23], which provided a voice-based kiosk solution for people in rural areas to create and manage information concentrated on literacy and the cost of using the system as the key user characteristics for making design decisions.

Targeting illiterate workers is mobile social software (*MoSoSo*) directory that enabled users to access listings for local businesses rates, view ratings of local businesses, and create password-protected shared directories that could contain business listings, ratings, and message boards [24]. Still, [25] presented work on a speech-driven agricultural query system. The objective of the work was to show that it is possible to innovate using telephones even with low-literate levels.

Examples of studies arguing for the overall ICTD intervention concepts in areas such as the DLM include that by [26]; [27]; [28]; [29]. Other related works include those that advocated for intermediated design and interaction [30]; [31]; [32]. These studies emphasized the importance of taking into consideration socio-economic issues of the target users. However, most of them did not go into the details of how to do it when it comes to actual software designs. In this study, we concentrated on intermediated interaction rather than intermediated design. We showed how various user characteristics narrowed down our design options into designing for the secondary users (field officers of the DLM NGOs) instead of the primary users (DLM job seekers). The aim was to increase the chances of the software applications adoption among our target group.

3. STUDY PROCESS

The case study areas were Nairobi, Kenya; Windhoek, Namibia; and Cape Town and Johannesburg, South Africa. In Nairobi, we worked with a group of the DLM workers from a worker collection point within the Central Business District (CBD). The Nairobi DLM was self-organised – meaning that it was formed and run by the workers themselves. In South Africa and Namibia, we engaged the intermediary organisations running the DLM by linking job seekers and employers. The intermediary organisations were NGOs formed and run as charitable organisations. The South African based NGO was called Men on the side of the Road South Africa [33] and referred to as 'MSRSA' in our study. Similarly, the Namibian based NGO was called Men on the Side of the Road Namibia and referred to as 'MSRNA'. We preferred to engage the NGOs because similar studies have shown that it reduces the study challenges [32]; [34]; [35]; [31]. The study duration was between September 2009, when we started with our preliminary field work study in Nairobi and May 2012 when we finished our study in Windhoek Namibia.

Since the objective of the study was to design software systems to help the DLM job-seekers and the DLM in general to operate effectively and efficiently, the research process involved user requirements gathering through extensive field work studies; literature and document review and many cycles of application prototyping. Literature survey on DLM and document review included MSRSA user manual; MSRNA and MSRSA websites reviews; and their web-based databases. The databases had a combination of over 19000 registered day-labourers and employers. The study process was exploratory and involved both uncovering issues that we thought were relevant and any unknown issue which arose during the study.

3.1 Field Studies

For the simple reason that most of the characteristics used for discussions in this paper emanated from the field work, we briefly highlight the various data collection methods applied in the field study. In the field, we took photographs of the situation, did voice recording, and used field notes to capture data. The types of information collected included the operation models of the DLMs; the travel routes and the locations where the DLMs stakeholders could be at any given time; the earnings and expenditure; technology use and ownership among the DLM stakeholders. We were also looking at understanding the kind of DLM activities. The details of the type of information are presented in Table 1. The data collection methods are described next.

3.2 Face-to-face Interviews

In Nairobi, we interviewed a total of 33 day-labour workers. In our first interview session, we talked to 5 workers in an unstructured informal interview. In the second session, we did a structured interview with a total of 14 job-seekers. Our third interview was a face-to-face interview with 10 job-seekers. We also interviewed five employers from Nairobi. We interviewed more than half of our interviewees more than once.

In Cape Town, for MSRSA, we carried out structured interviews with 11 intermediary organisations' employees; three MSRSA DLM employers and over 20 day-labourers. Throughout the study, we had many unscheduled informal discussions with over 50 workers in Cape Town. In MSRSA Johannesburg branches, we conducted face-to-face interviews with two regional managers. We also interviewed four MSRSA office employees (two from each branch/region) and ten randomly selected day-labourers. In Windhoek, Namibia, we applied structured face-to-face interviews to the head of MSRNA, one field officer, one office worker and a total of 20 day-labourers. We also conducted a face-to-face interview with Mr. Gonzo, the co-author of Day-labourers in Namibia [20], who summarised the Namibia DLM based on his book.

3.3 Telephone Interviews

Before and after visits to Windhoek, we used telephone (using Skype) interviews and E-mails to collect data. Through Skype calls, we interviewed the head of MSRNA once and the office worker several times. We exchanged many E-mails with the head of MSRNA and the office worker on how they operated and their technological requirements. The same information as that collected using MSRNA website, E-mails and Skype call interviews was collected during face-to-face interviews. The details of the information collected are presented in Table 1. We mostly used Skype call interviews and E-mails because we were based in Cape Town, which is several kilometers from Windhoek.

3.4 Shadowing and Observation

We shadowed and observed the many day-labourers at the various collection points in Nairobi and Cape Town, six MSRSA office employees and three MSRSA field officers for four consecutive months in Cape Town. During the entire study period, we interacted and talked with over 100 day-labourers; 23 intermediary organisations' employees and eight randomly selected DLM potential employers.

Our observations involved two days of field work per week for over four months in Cape Town, a total of eight days observation in Windhoek, two days in Johannesburg and several days in Nairobi. We were observing:

- How the workers approached the employers and mobile phone use: To find out if employers came to pick workers at the collection point or request for them through the mobile phone calls and whether the job-seekers scrambled for jobs (as seen in Cape Town) or they were more organised. In South Africa and Namibia, where DLM organisations had management information systems (MIS), we observed how the stakeholders used the MISs.
- How the worker collection point was organised: The objective was to understand how the job-seekers were being organised. We were looking at how the DLM stakeholders interacted and their relationships. For example, how the field officers engage day-labourers or the employers
- The movement of the DLM within and outside the collection point and the role of the field officers in the collection point and finding jobs: we observed how the job-seekers and the field officers related in terms of job-search related activities. The objective was to confirm the existence of intermediation, or lack of it, among job-seekers for the DLM in the South African case studies. The outcome would justify the intermediation design.

3.5 Questionnaires

Because of the limited resources to extend the field work in Windhoek, Pretoria and Johannesburg, we used a short simple structured questionnaire administered by three field officers in Pretoria and Johannesburg and the office employee in MSRNA. The field officers were trained on how to administer the questionnaires. The questionnaire for Pretoria and Johannesburg was a kind of guide for the field officers to carry out a structured interview with the worker. The main data captured included commute distance; time, cost and technology use. A total of 90 workers answered the questions by the field officers.

The questionnaire for MSRNA Windhoek was intended for workers themselves. They would answer the questions with the help of the MSRNA office worker. The information collected was age, phone type, communication, airtime, cost of transport, means of transport and daily earnings. A total of 12 day-labourers filled the questionnaire. The questionnaire's objective was to capture basic information about the day-labourer. The questionnaire, just like the structured interview questions used in the three case studies, was developed guided by existing DLM and ICT4D literature coupled with the objectives of our study.

3.6 Other Methods

As a method for gathering the information, we also analysed the MSRSA and MSRNA database which had information about workers, employers and job allocations for a period of five years from 2006 to 2011. And to understand the DLM, we also discussed our objectives with many of our friends, colleagues and family members some of whom were day-labourers and potential employers of the day-labourers.

3.7 The Type of Information Collected

Table 1: Information collected and for what purpose

Type of information collected	Purpose
Workers' literacy	Compare the text literacy levels among the day-labourers in the three case studies. This would help us in making important design decisions.
Mobile phone ownership	Make decisions on whether to directly design mobile applications for the DLM and for the comparisons across the case study DLMs.
Mobile phone use	The use of mobile phones, whether sharing or otherwise, would help understand the dynamics of designing in such environments.
Amount of airtime on phone	Gauge the affordability of day-labourers in using the mobile phone applications we had as design concepts.
Job search strategies	To find out whether job-seekers used any other strategies such as making or waiting for phone calls; going office to office or any other.
Worker search strategies	To understand how employers searched for workers. To find out whether they used any form of ICTs including those provided by the NGOs.
Job allocation formulas	For purposes of understanding and hence designing remote applications that would allow field officers allocate jobs to workers remotely.
Commuting frequencies	To know how frequently workers and employers travelled in search of jobs and workers respectively. The idea was to use these frequencies to check if ICTs affected travel.
Commuting means	To find out whether job-seekers used any means of transport or walked to the collection points. The purpose was to link it with the cost (time and money) of travelling associated with job searching.
Commuting costs (money)	To find out the workers' cost of commuting to the collection point. This was to be used to measure the impact of the ICTs interventions.
Commuting time	To find out how long it took a job seeker to travel to the collection points. The purpose was to check if travel time was one of the challenges of job search and if it would be reduced by using ICTs to reduce travel.
Commuting distance	To find out the average distance to the collection point from a job-seekers home. The purpose was to see if it would be reduced by using ICTs.
Job seeker earnings	To find out how much a DLM worker earns. The purpose was to find out if they would be regarded as poor.
Job-seekers daily spending	To find out how their average daily spending. The objective was to compare it with the earnings to see whether they had any savings.
Worker's out-of-work frequency	The average number of days in a week a day-labourer would be out of work. The purpose was to know how frequently a worker would be job hunting.
Operation mode of NGOs	Finding out whether the NGO was a self sustaining or charity dependent in order to understand the design requirements for the individual intermediary organisations.
The cost of job search	To find out the operation expenditure of a job search for workers and the NGOs. The purpose was to use it to find out whether the prototypes had any impact by comparing the costs of operation before and after our interventions.
System usage data	A log of usage records was kept to find out the number of users for the deployed applications.

4. RESULTS

Although the general objective was to design systems for the DLM as a whole, we were mostly interested in designing applications for the day-labourers because of them being the bearers of most challenges observed. As a result, most of the information presented here was collected about the day-labourers. In this section, we present the findings on key issues which we hypothesised as the determinants in technology ownership and use, and hence design decisions. In the discussion, we highlight the importance of these findings to our design decisions.

4.1 Demographics

All the job-seekers in South Africa who we interacted with directly or through their field officers were men between 21 and 55 years of age. The youngest was at 21 while the eldest was a 55 year old day-labourer. The average age obtained by analysing the MSRSA database stood at 35.8 while 35.6 years old was the average age obtained from field data collection. Figure 1 shows the average age of day-labourers from the four case studies. Just like many other characteristics displayed by day-labourers, age and gender were consistent across all the case studies. The maximum average age was 44 years and was found in Nairobi.

Although MSRSA and MSRNA supported women job-seekers, all the job-seekers we interacted with at the collection points were men. We did not see any woman job seeker at the collection points that we were studying. We did, however, meet women job-seekers at the MSRSA offices. One such Lady was coming to the office to register and look for a home care job. For the three days that we saw her at the office, she was not successful in getting a job.

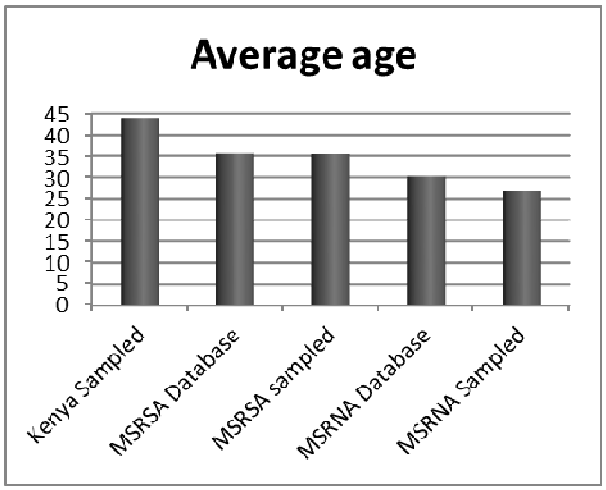

Figure 1: Average ages of day-labour workers for the three case studies

The average age was obtained from either using a sample of data collected in the field work using questionnaires or face-to-face interview or by analysing data in the databases. Kenya did not have a database and hence has the field sample data only.

4.2 Technology Ownership and Use

The question here was whether the day-labourers owned or had access to technology and how they used it. We were specifically interested in how day-labourers used technology on job search related activities. We were also looking at the flexibility of the technology with regard to software application design. The technology of interest included the mobile phone, fixed line telephone, computers and the Internet. Overall, technology ownership and use among the workers was minimal. For instance, findings from Cape Town showed that 30% of the workers owned mobile phones. Mobile phone ownership had a direct correlation with education level and skills. This was seen for example, in our first interview day at Fishhoek collection point in Cape Town, three jobseekers who had mobile phones had education levels of grade 12. This is compared to the rest over ten job seekers who had no mobile phones and had education levels of below grade 10.

In all the three case studies, most of the mobile phones were low end mobile phone handsets (also referred to as feature phones). These are mobile phones that have limited programmable features i.e. their operating systems provide very limited programming interface. They are basic mobile phones used mainly for calling and texting. Some of these mobile phones do not support some advanced USSD applications such as M-PESA applications. Examples of these mobile phones include Nokia 1202 and 1200; MTN-ZTE, Vodafone and basic Motorola phones. The market price of such mobile phones during that time was between ZAR 130 to ZAR 200. Majority of those who did not own mobile phones had access to them mainly through their spouses and reported that they could be reached through them in the evenings or early mornings. Overall, the 90% of the mobile phones owned by the sampled day-labourers were non-programmable mobile phones. Figure 2 (a) and (b) shows the share percentage of mobile phone models and programmable and non-programmable mobile phones owned by the sampled day-labourers respectively.

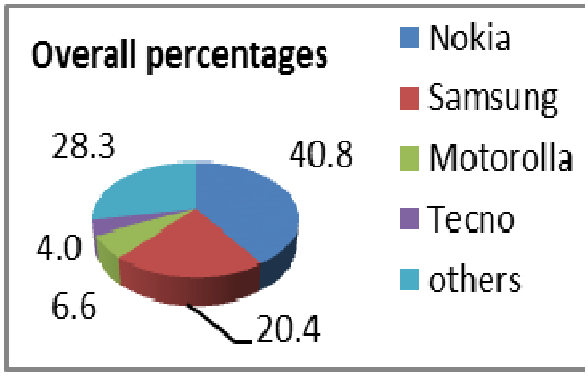

Figure 2 (a): Mobile phone models among workers

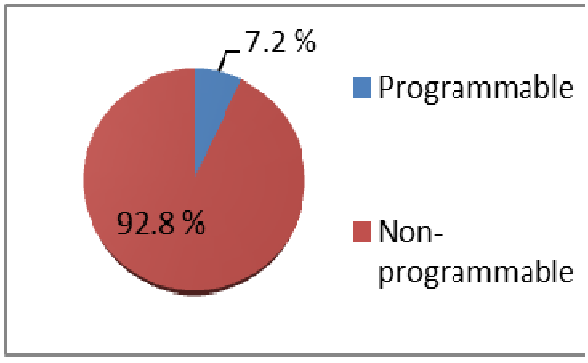

Figure 2 (b): Percentage of programmable mobile phones among workers

The difference in technology use and ownership among the day-labourers was not in the three countries but in the cities. More job-seekers owned mobile phones in Nairobi and Johannesburg than in Cape Town and Windhoek. The use also followed similar trends as ownership. With regard to affordability, and hence use, it was far much cheaper to call in Nairobi compared to South Africa and Namibia. Figure 3 shows a graphical comparison of the airtime on phone while Table 2 compares the communication time for a ZAR 10 airtime.

For all the South Africa and Namibia case studies, those who did not own mobile phones reported having access to one in the evenings or morning hours at home or through their colleagues during the day. A majority (over 90%) of the day-labourers we interacted with in Nairobi owned and used mobile phones. Those who had mobile phones reported knowing how to use SMS and voice call services. However, majority reported lacking enough airtime. As a result, calling or sending an SMS for them remained prohibitive. While the average airtime on the phone was found to be ZAR one in Cape Town, through questionnaires administered to 90 workers by the field officers, we found that the average airtime on the phone for job-seekers in Johannesburg was ZAR 9.76. Figure 3 shows the average phone airtime for all the four cities during the time of interview or questionnaire filling.

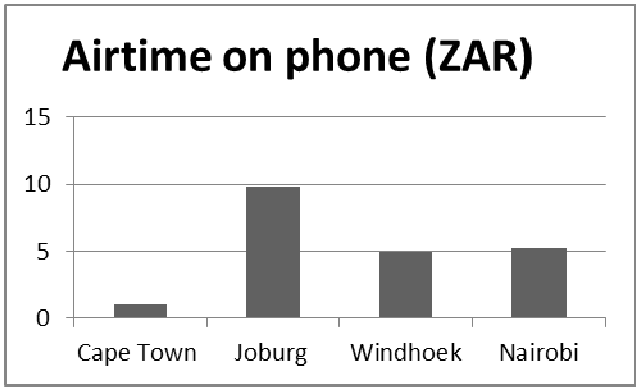

Figure 3: The amount of airtime on phone the job-seekers had during data collection

Table 2: The average calling rates per minute for Kenya, South Africa and Namibia

Country	Average cost of calling per minute (pre-pay)	Number of minutes for ZAR 10 airtime
Kenya	0.0335	29.85
South Africa	1.58	6.33
Namibia	1.5	6.67

From Table 2 and Figure 3, workers in Nairobi would have about 15 minutes calling time with their ZAR 5 airtime compared to about 3.1 minutes for South Africans and Namibians for the same amount of airtime. None of the job-seekers interviewed had access to fixed landline telephones at home. They would only use the landline telephones at the calling public booths. Similarly, none of the interviewees knew anything about other mobile phone services or applications provided by mobile service providers.

For example, MXIT[1], which is a free online instant messenger running on close to 3000 mobile handsets, and had been adopted by many South Africans, was found not to be popular among the job-seekers in Cape Town. Internet and E-mail was also not popular among the workers. For instance, of all the workers interviewed in Cape Town, except for one, the rest had only heard about the Internet and E-mail but did not know much about it. The one exception had an E-mail address and reported using it in a cyber café whenever he had time and money. Interestingly, the man with an E-mail address did not own a mobile phone. When asked if they knew about MSRSA/MSRNA web site or any other such job-search related web-based service, none of those interviewed in Cape Town and Windhoek, Namibia responded in the affirmative. In Johannesburg, out of over 10 workers interviewed during our visit, only two workers reported having used the MSRSA website. Similar trends on use of Internet and E-mail emerged for Nairobi.

4.3 Education Level and Worker Skills

Except for the minor differences in the characteristics displayed by workers, the job-seekers from different regions shared a lot of similarities with regard to education and skills levels. Education level among day-labour job-seekers in South Africa was found to be relatively low compared to the other day-labourers from other cities like Nairobi, Johannesburg and Windhoek. The skills set and language/communication issues followed from education (See Figure 4 for a comparison of education levels). Workers from Kenya reported more skills compared to those in Namibia and South Africa. Further, workers in Kenya did not experience any language barrier as was seen in Cape Town and Windhoek. In Kenya, all the day-labourers in Nairobi communicated using the common Swahili as their universal language. Language barriers were, however, found not to be a problem during job search. The job-seekers worked in groups leading to having translators among themselves.

In South Africa, among the day-labourers interviewed, 70% attained an education level of grade eight and below. Only 15% had completed grade 12. However, on analysing the MSRSA database of close to 19000 registered workers, we found that 47.78% of all the workers had not gone to school above Grade 10. The disparities may have been because of a possibility that the registered workers were more educated than the non-registered ones.

[1] http://mxit.com/

In Cape Town, where we spent more time, we sought to directly find out if our interviewees could read or write. We sent them SMSs and asked for a reply while we were still in the vicinity. However, this test did not succeed at the first instance as only 18% of all the workers at the testing time had mobile phones. Because our interviewees did not have airtime on their mobile phones, we decided to give them airtime worth ZAR 10. The airtime was given in the form of vouchers and the purpose of this was so that we could ask them to reply to our SMSs and act as an incentive. All those who had mobile phones replied successfully after being given airtime on their phones.

On map usage, only 20% of those interviewed preferred to use a map when finding a new location. Sixty two percent (62%) preferred to be picked by employers and did not see the need for a map. As an interesting finding, a few of those who did not have mobile phones likened it to the map and said that just like one does not need a map, they also do not need a mobile phone. Their argument was that, if an employer needs certain skills, he/she would look for it at collection points. However, taking directions from the employer through the mobile phone was still the preferred way of locating a job station. We asked about the use of the map because we found the DLM NGOs asking potential employers to forward a map showing the directions to the work station alongside any request for workers.

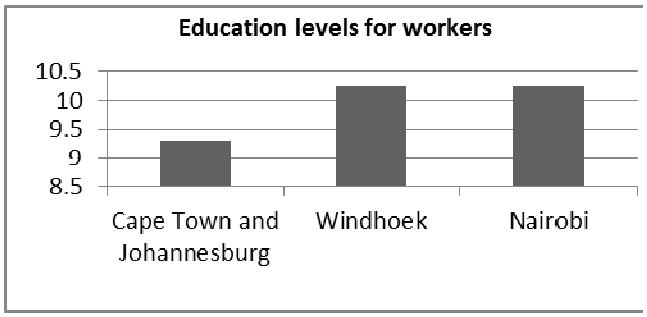

Figure 4: Education level comparisons from the three case studies

Windhoek and Nairobi had the highest education levels (average of grade 10.2) compared to Cape Town which had an average of 9.3

4.4 Earnings and Expenditure

The average earnings for day-labourers did not show any major differences. While workers in Cape Town and Johannesburg earned slightly more than their counterparts in Nairobi and Windhoek, their cost of living was found to be high. For example, looking at the cost of commuting, Johannesburg comes top, followed closely by Cape Town. As much as Windhoek has high cost of transport, interviewed workers gave half the cost of commuting as they normally walk one way. That explains why the commuting cost is low in Windhoek. Figure 5 shows the earnings and the commuting cost for workers in the three case studies.

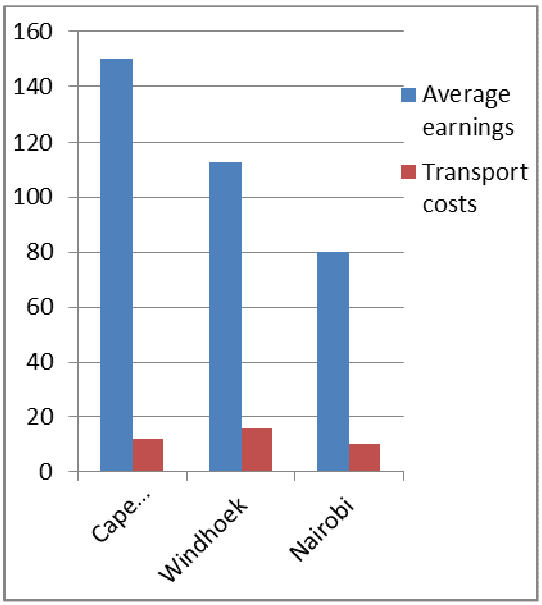

Figure 5: Average earnings and commuting costs (in ZAR) for workers

Figure 5 shows average earnings and transport costs (for Nairobi, Windhoek and Johannesburg and Cape Town). The average transport costs are comparable in Nairobi, Johannesburg and Cape Town. The daily average earnings are higher in Cape Town followed by Windhoek.

DLM worker earnings fluctuated depending on the employer; job type; skills required and even time of the year. On average, the job-seekers reported the daily income earnings in Cape Town to be ranging between ZAR 150 and ZAR 350. Daily expenditure averaged about ZAR 12, a bulk of it being fare to and from the worker collection points or the work station. Those with mobile phones would spend less than ZAR two per day to call or SMS. We were only interested in earnings and expenditure related to job search activities.

4.4 Commuting

The key reason why we wanted to understand the commuting patterns and the cost is because we were keen to find out how technology can help in reducing the challenges of the DLM workers, having found commuting to be a key challenge. Commuting for job-seekers involves using public transport means or walking to collection point or to work station. We used both interviews and questionnaires to find out their commuting means, times, distance and the costs involved. Some workers indicated that they always walk to the collection point all the time. However, a majority of them indicated that they used the Metro train or Taxis (public transport motor vehicles). A few of them reported using the public transport taxi services (cabs).

4.5 Education Level, Literacy and Language

There was a link between literacy, skills and mobile phone ownership among the job seekers. Day-labourers who owned mobile phones had education levels of grade 10 and above. The 30% of the workers in Cape Town who owned mobile phones had education level of grade 12. Likewise, a majority of skilled workers owned mobile phones. For example, in Nairobi, we found that majority of the workers we interviewed had education levels of above grade 12. Of all these same workers, 100% reported owning mobile phones. Following from the trend that skilled workers were more likely to have had education level of above grade 10, the ownership of mobile phones by the skilled workers backed the assertion that education level had direct effect on mobile phone ownership**.**

5. DISCUSSIONS

In the discussion, we look at two main contributions of the paper. First is on key design decisions that we made and which were informed by the findings about the DLM workers' characteristics. We draw our discussions from the findings on specific characteristics which we regarded as important because of how they would affect the design and decisions made throughout our study process. In the second part, we highlight some important unique features of our research.

5.1 Implications to Design

5.1.1 Technology Ownership and Use

The ownership and hence use of technology was limited among the day-labour workers. There was no landline; e-mail or Internet access, hence limiting our technological innovations for the DLM workers. The only reasonable feasible option was the use of mobile phones applying intermediated use [32] despite having low ownership and use levels. The discovery of the low mobile phone ownership among job-seekers in Cape Town and Windhoek changed our design decisions for the mobile phone applications. We redesigned the prototypes for field officers rather than for job-seekers and for potential employers. Further, having not dropped the idea of designing for job-seekers and employers, we designed for the Nairobi DLM, where preliminary field findings had showed over 90% ownership of mobile phones among day-labourers.

The usage characteristics were complex. For example, in Windhoek, Namibia, the male workers reported using their spouses'/partners' or their mothers' mobile phones to receive phone calls. This characteristic brought about design considerations that would allow usage even when sharing the devices. It eliminated the assumption that workers have full access to mobile phones.

5.1.2 Education Level, Literacy and Language

There was a link between literacy, skills and mobile phone ownership among the job seekers. Day-labourers who owned mobile phones had education levels of grade 10 and above. The 30% of the workers in Cape Town who owned mobile phones had education level of grade 12. Likewise, a majority of skilled workers owned mobile phones. For example, in Nairobi, we found that majority of the workers we interviewed had education levels of above grade 12.

Of all these same workers, 100% reported owning mobile phones. Following from the trend that skilled workers were more likely to have had education level of above grade 10, the ownership of mobile phones by the skilled workers backed the assertion that education level had direct effect on mobile phone ownership. The main objective of finding out the language literacy for workers was to check if language barrier was among their challenges. Although we found that there was no communication barrier between workers and employers because the workers worked in groups, there was a likelihood of creating a communication barrier for workers who could not read or write in the official language of communication. We planned to mitigate this by designing voice applications as proposed by other studies such as [18]. However, we still faced the challenge of low ownership of mobile phone devices and lack of access of other technologies such as landlines among workers especially in South Africa and Namibia. In the end, this led to intermediated use and direct use designs for Cape Town and Nairobi respectively. With our findings, we cannot say with certainty that education level dictated the characteristics of the day-labour workers. However, we could associate some characteristics of different DLM workers with their education levels. For instance, in Kenya, the day-labour workers who had registered companies for quotations had an education level of over grade 12.

5.1.3 Earnings and Expenditure

The main purpose of interrogating the job-seekers balance sheet was to find out if their earnings matched their expenditure and if they made ends meet. If they met their basic needs, then we would have the justifications to convince them to spend more to run the proposed software applications. More specifically, if waiting on the road side each day was worth it for the workers. We were also finding out the significance of trying to reduce their travel to the collection point. If their expenditure would reduce by a reasonable margin after adopting our software systems, then we would justify any design factoring in significant reduction of travel for workers. Besides the workers' earnings and expenditure, we also looked at the cost of using technology, especially the mobile phones, in the three case study areas.

Results showed that DLM workers lived a subsistence life. They barely made ends meet. As a result, we could not design software applications which would require workers to spend extra money. With the figures obtained, it was clear that workers should be able to significantly save on transport costs if they adopted ICTs to reduce travel. As a reaction, we designed and implemented software systems that allowed the field officers and workers reduce travelling distance by allowing them to communicate without having to travel to the collection points in some instances. With regard to the cost of technology, overall, the cost of using the mobile phone services was high for workers. Further, other technological options such as the Internet and landline services were not available for workers. This meant that, apart from thinking mobile phones (because of their availability), we also needed to think of cheap options for the users (field officers as intermediary users) and, hence, we settled on mobile applications which used data over the Internet—the cheapest available option then.

5.1.4 Demographic Characteristics

Demographic characteristics of workers were similar in all the three case study areas. Interesting variables such as age did not vary much and, at the same time, was not seen to be affecting the ownership and use of technology, for example the mobile phones. The key reason for considering age and gender was because they have been shown to influence technology adoption and use [14]; [36]. For example, [37] found out that the older adults were less likely than younger adults to use technology in general. Overall, we had no design decisions influenced by the demography as they were overshadowed by the other characteristics such as literacy and technology ownership and use.

5.1.5 Other Unforeseen Characteristics

As much as the primary objective of the DLM job seekers going to the collection point was to look for jobs, we learnt that job-seekers went to socialise and discuss current political affairs. Other reasons of visiting the collection point included workers not having any other activity to do or even going because they did not have any other place to relax. Our design decisions were therefore influenced by the different needs of the workers. In general, the need to have technological interventions that serve the DLM must consider not only their primary objective but also their other perceived benefits which may include socialization.

5.2 Important Unique and Common Characteristics

5.2.1 Micro-studying

The main strength in our study was in the method rather than the results. We micro-studied the characteristics of our participants as opposed to using other factors to make conclusions. We used the actual measurements of issues affecting the users. These included the ability of the job seekers to read and write; their actual earnings and expenditure; the exact amount of airtime on their mobile phones at any given time as opposed to generalizing from earnings; the number of kilometers they walked and the amount of money they paid for transport whenever they used a public means of transport. The difference in our study is for example; in many studies e.g. [10], GDP is used to predict the affordability of the mobile phones among participants. In this study, we went out to find the actual cost of the mobile phones and, at the same time, we asked the participants the kind of devices they would afford. On literacy levels, we used text messages to find out if our participants, especially the DLM workers, would be able to read or write. For those who owned mobile phones, we asked them what they used the mobile phone for, with intention of knowing if they used it to look for a job.

5.2.2 Findings

Perceived benefits: In our findings, other characteristics such as perceived benefits such as socialization among stakeholders showed that they would play an important role in deciding the kind of software application to design. This was not unique as had been shown by other technology adoption studies such as [4], which proposed a Mobile Phone Technology Adoption Model (MOPTAM), which emphasises the importance of Social Influence and Facilitating Conditions like system service, costs and quality.

Demographic characteristics: In our study, the mobile phone ownership among the DLM workers was not affected by age bracket. Although [39] was talking about mobile phone use, they found a similar verdict indicating that mobile phone usage by the elderly might not be very much different from that of younger people or adults.

Intermediation and sharing: Studies which have advocated for technology use or design through intermediation have shown that the illiteracy and lack of technical knowhow of the participants were the major reasons of intermediation (e.g. [30] and [32], [31]). In our study, we found that intermediated use of technology was not entirely because the DLM workers could not read or write but mostly because they could not afford the mobile phones' cost of ownership and usage. The complexity of design versus understanding the unique characteristics of the stakeholders: While some similar studies choose to deal with one among the many complex problems e.g. language problems or literacy [18], some choose to provide very simple solutions based on the kind of devices users have e.g. [40]. In this study, because we were interested in understanding the unique characteristics of stakeholders, we chose to look at the problem in totality.

For example, we would have only chosen to design voice applications incorporating language translations. However, we noted it was only going to be a complex solution but only solving one problem leaving out others such as affordability of the service. We realized that the cost of sending SMS or calling was still relatively expensive among the DLM workers and hence used data bundles which was the cheapest option available. The low mobile phone ownership was due to the cost of owning a mobile phone which was still high. To mitigate this, we adopted the intermediated use which allowed field officers to use the system on behalf of the DLM workers. Overall, although earnings and expenditure are used in technology adoption, access, use or ownership, they have not been widely studied as part of the design decisions.

Functionality versus a wide range: Many studies that relate to lower income earners design solutions that use SMS because of its simplicity and it being able to run on many handsets. This approach is readily available and favors a wide range of devices and users but provides simple functionality [41]. The kind of systems we found suitable for the DLM needed to support many of the complex activities by the DLM stakeholders especially the field officers who were technologically sophisticated. This is mainly why we did not consider designing SMS based applications.

Mobile phone ownership: A majority of the DLM workers from Namibia and Cape Town did not own mobile phones. However, these workers had access to mobile phones mostly in the evening and in the mornings. This was contrary to findings from Nairobi which showed over 90% ownership of mobile phones among the DLM workers. Our deduction here is that, although the workers from the three different regions may have had similar characteristics, their technological ownership and use needed to be studied in context to avoid making incorrect generalization.

6. CONCLUSIONS

In this paper, we have discussed the importance of the characteristics of the target users in designing ICT artifacts in an ICTD context. In showing how the data we collected shaped our design decisions, we conclude that it was not possible to design for the DLM job-seekers directly because of the diverse reasons depending on the case study. The low-literacy rates and low ownership and use of mobile phones were the main reasons. Majority of the less-skilled workers in South Africa and Namibia were text illiterate and could therefore not be able to use text based mobile applications. Besides literacy, majority of the workers did not have access to mobile phones. Even those few workers who had access to them had the non-programmable (low end) mobile phones. We could not therefore build systems for these non-programmable mobile devices, hence another reason for not building applications that would be used directly by workers. Other reasons included low income levels not matching the higher expenditures by the workers and the cost of using technology in the three case study areas. Any technological intervention for workers that would require them to spend extra monies would not have been viable. Indeed, the problem of participants of not having the technology or being illiterate has been cited as some of the main reasons why it is challenging to design directly for the primary user [30]; [6]; [32].

Although the study was only based on a single case of the informal sector, the DLM, we believe that the importance of these characteristics in informing design decisions cannot be underestimated in all the other sub-sectors of the informal sector. If ignored, the interventions may worsen the intended users' conditions and, in some cases, even increasing the digital divide. As a result, we decided to look for an alternative—designing for the intermediated use—for intervening that would cover the majority workers instead of designing for the minority workers.

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