

SHOP-Net: Moving from Paper to Mobile

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Abstract

Stock-ordering is one of the challenges that microenterprises face, because shop owners often need to leave their shops to travel to suppliers of goods. Triple Trust Organization (TTO) is a non-profit organization (NGO) that works with microenterprises around Cape Town and addresses this problem. They act as a supplier and fetch stock orders from shops they work with. Their ordering system relied on paper order forms and had a number of inefficiencies. To address these inefficiencies, a mobile-based stock-ordering system was designed with TTO. This system allows orders to be recorded and sent to a server at the TTO office using a mobile phone application where the orders are then processed. This system successfully increased TTO's efficiency in three ways, namely, improved data processing ability, increased order accuracy and increased access to information. The evaluation was done according to their success criteria and the system has been in use for seven months. We argue that evaluations with NGOs should go further than just the management but include all of those affected by the system.

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1. Introduction

Informal traders face many challenges, not least of which is the purchasing of stock. Many shop owners are forced to leave their shops in order to procure stock from suppliers (Hasson, 2010). This project will investigate the viability of creating a mobile stock-ordering service for microenterprises in partnership with a non-profit/non-governmental organization (NGO), namely Triple Trust Organization (TTO). The goal of the research will be to investigate if information and communication technologies (ICTs) can be used to improve TTO's efficiency and to see what impact those changes will have for TTO and their clients.

1.1. Environment

Townships form a part of many South African cities. They are informal settlements where people from smaller towns or rural areas have moved, often for the prospect of finding a job. Since many of the inhabitants arrive with little wealth, make-shift homes are erected using scrap-metal in the form of shacks. Townships often grow regardless of city planning and new shacks are erected without running water, electricity and road access. The lack of road access makes a journey to the nearest formal retailers more difficult.

The combination of poor people seeking employment and the inconvenience of going to formal retailers provides an opportunity for the unemployed to start informal shops in the community. These informal shops are known as *spaza* shops. Spaza means "hidden" because these shops were illegal during Apartheid. Even though they are no longer illegal, the name has remained. Spazas are typically small and run from the owner's lounge or garage, trading in day-to-day consumables and domestic items. They are plentiful in townships and informal settlements across South Africa.

Spazas face many challenges though. Shop owners often have to leave their shops in order to procure stock, as noted by Hasson (Hasson, 2010). Although they make it more convenient for locals to purchase day-to-day items, they now bear the inconvenience of purchasing the stock. Any time spent away from the shop is usually time lost because potential customers would simply go to another spaza. Sometimes a family member will run the shop while the owner is away purchasing stock to reduce this impact.

Spazas also typically purchase stock from retailers rather than wholesalers due to accessibility. This makes it difficult to have competitive prices and often means that their draw-card is the convenience they provide for locals.

1.2. Triple Trust Organization

TTO is an NGO based in Cape Town. Their work is in poverty alleviation through enterprise development. TTO works primarily with spazas in townships on the outskirts of Cape Town. They provide business mentoring, training and advice to the spazas associated with them. They also address the problem of spazas purchasing stock from retailers by acting as a supplier of stock to spazas. Spazas order stock through TTO, which purchases the stock from wholesalers rather than retailers. The stock-ordering process is carried out using paper forms, and is unsatisfactory due to a number of problems and inefficiencies such as the distance to the spazas and a lack of easily-available information.

Since TTO is a non-profit organization which seeks to serve microenterprises in this manner without adding burdensome costs from these enterprises, TTO largely relies on funding from a number of private and governmental donors. (Triple Trust Organization, 2012)

1.3. Partnership

When working in unfamiliar contexts, it is usually beneficial to work through an NGO because the NGO has already established a relationship with the community and has a better understanding of the context than an outside researcher would (Medhi, 2007).

For this reason, this project was carried out in partnership with TTO, since they are already active with many spazas in the community and are in a better position to leverage an ICT intervention.

Precisely what TTO does and how their stock ordering process works will be investigated and described in this thesis. This will inform the design of a system to move the ordering process from a paper medium to a digital, mobile medium.

1.4. Research Questions

Through this project we will explore and evaluate the following two research questions:

Research Question One: Can we migrate TTO's process and personnel from a paper-based approach to one using digital technology? – can we work with TTO to gain an understanding of their practice sufficiently well that we can, with them, design and implement an alternative to their existing system

Research Question Two: If we can indeed implement the system, will it improve the running of the NGO? – Gitau and Marsden (Gitau and Marsden, 2009) make the argument that in ICT4D projects with an NGO partner, we should adopt the success criteria of the NGO. Therefore we will determine how the NGO measures its own success and use those criteria to evaluate our project

2. Background

This chapter will introduce the background of the project. Information and Communication Technology for Development (ICT4D) will be introduced as well as the use of mobile phones in developing-world projects. Work by other researchers relating to the main problem areas of this project will then be discussed.

2.1. Information and Communication Technology for Development

Information and Communication Technology for Development (ICT4D) is a relatively young research field. For many years, groups of computer scientists have considered how best to apply technology to the developing world, but ICT4D as a discipline began taking shape during the mid to late 1990s. With the rise of the internet and personal computers, many governments and development agencies were eager to make this technology available to the public, especially the poor and those in rural areas where computers were otherwise too expensive. The result of this intent was the rollout of many telecenter projects in those areas. Telecenters are buildings or rooms with a number of computers connected to the internet for public use. While these projects successfully brought internet access and available

computers to many rural villages, they were often unused or unmaintained (Galpaya et al., 2007). This was largely due to the mismatch between assumptions about the users and their requirements, and the reality (Heeks, ICT4D2.0). (Benjamin, no date)

A number of obstacles in linking technology with the poor and rural population started becoming apparent. To name just a few: power relations in communities where social power is very prominent (De and Ratan, 2009); internet connectivity challenges due to remote locations (Hasson, 2010); and intermittent power supply in many areas (De and Ratan, 2009).

Because of the early failures of the telecenters and the growing understanding of the types of challenges faced, the ICT4D discipline and development agencies began taking much more seriously input from other disciplines such as anthropology, sociology and development studies. There was a growing sense of humility as researchers realized that none of the disciplines had all of the answers, but rather that discussion and collaboration was in order.

During this time the mobile phone market grew rapidly. The number of mobile subscribers in sub-Saharan Africa (excluding South Africa) went from zero in 1994 to over 82 million by 2004, with an annual average growth rate of 58.2% between 1999 and 2004 (Mbarika and Mbarika, 2006). In the developing world, mobile penetration rates were expected to reach 68% of the population by the end of 2010, with Africa at 41% of the population (ITU, 2010). With six of the 53 African countries passing 90 mobile subscribers per 100 people in 2009 (ITU, 2010), the growth rate is slowing somewhat to about 10% increase per year in Africa (ITU, 2010).

The unplanned side-effect of the proliferation of mobile phones in the developing world is that 68% of people living in the developing world have access to a computing device. Where telecenters failed to bring computers and internet connections to the rural and poor population, mobile phones have succeeded. Mobile phones have had such rapid growth in Africa and the rest of the developing world for a number of reasons: the devices themselves are relatively cheap, especially when bought second hand; because they have batteries, intermittent power supply throughout much of Africa does not mean intermittent connectivity; the rollout of cellular infrastructure is relatively cheap compared to the rollout of fixed line infrastructure; the ability to “pay as you go” rather than being tied to a monthly subscription lowers the risk for new mobile users. The mobile phone has become the computing platform for the developing world.

Mobile phones have had an impact on the ability of Africans and those in the rest of the developing world to communicate. Where people would have had to walk to physically talk with friends, mobile phones have allowed communication at a distance, primarily through SMS and, for small business owners, also voice calls (Donner, 2006). This is especially valuable when people would have had to travel large distances between villages, or when physical communication was impossible, such as when friends or family members were in other countries.

Apart from social communication, mobile phones have also greatly supported business communication (Donner, 2009a) (Abraham, 2007). One example of many is of a baker named James in Rwanda. He purchased a mobile phone allowing customers to phone to place orders. He was also able to start

ordering ingredients and other materials via his phone. He estimates his mobile phone has caused a 30% increase in business, allowing his family to move into a larger home (Donner, 2009a).

Most of the mobile services in Africa are provided using only a mobile phone's regular functionality, such as voice calls and the use of SMSs (Donner, 2009b). More recently, services have been made available via mobile phone applications. These include healthcare (Anokwa et al., 2009) and business services (Donner, 2009b) as well as media creation (Frohlich et al., 2009) and sharing (Maunder et al., 2008).

2.2. Mobile Phones and Microenterprises

In the context of mobile services for small and micro enterprises, the use of mobile phones can usually be placed into one of four categories: market information services, virtual marketplaces, financial services, and direct livelihood support (Donner, 2009b).

2.2.1. Market Information Services

One of the big problems for goods producers is knowing what price they will be able to charge for their wares. This is especially true when the goods are perishable, such as those produced by fishermen and farmers, where there is little time to scout for the best deal. Market information services seek to address this problem by making regional pricing information available for specific agricultural products. This helps to reduce price variance between markets because producers will be inclined to go to the markets that are paying the most for those goods. These services are primarily made available via SMS although some are web-based. Two examples of market information services are the Livestock Information Network Knowledge System (LINKS) in Kenya and Infotrade in Uganda (Donner, 2009b).

2.2.2. Virtual Marketplaces

Virtual Marketplaces try to link buyers and sellers of goods and services. Some virtual marketplaces also match employers and job seekers. They do not typically facilitate transactions or delivery services, but simply link the buyers and sellers. Two examples of these are the National Farmers' Union in Zambia and Google Trader in Kenya (Donner, 2009b). The National Farmers' Union provides aggregated prices and contact information of interested buyers. Google Trader provides a platform for the exchange of anything from homes to products to services.

2.2.3. Financial Services

There are two main financial services provided via mobile phones. These are "mobile banking" and "mobile payment" services and are typically provided by banks, third-party agencies and mobile operators. These systems are supported by partnering banks and shops where one would be able to deposit funds into, or withdraw funds from their online account. These funds can then be sent to friends and family or can be used to draw cash or pay for goods at partner shops. Early on, this was marketed mainly at people who worked far from home to allow them to send money back to the family. Since then, it has grown substantially as more businesses began to offer the service and accept payments using it. The most well-known example of this is M-PESA from Kenya. Others include MTN Mobile Money and Zain Zap (Donner, 2009b).

2.2.4. Direct Livelihood Support

Direct livelihood support is a relatively small category of systems that help entrepreneurs to make a living directly off their mobile phones. An example is the Grameen Village Phone system started in Bangladesh. Entrepreneurs would borrow money to purchase a mobile phone and some airtime. They would then allow others in their village to use their phone like a public payphone, and earn a living in doing so (Donner, 2009b).

There is another small category called Business Development Services (BDS). These services seek to gather, develop and share knowledge about how to develop small enterprises. In 2009, “no instances of BDS services delivered via the mobile channel were evident in Africa at the time this review was compiled” (Donner, 2009b).

The work of this project does not fit comfortably in any of these categories but, in some sense, sits on the edge of the BDS and virtual market places categories. There is an aspect of improving the link between buyers and sellers, namely the spazas and TTO, by seeking to improve the ordering process. TTO provides a BDS in terms of supporting and training spazas and, while this project does not directly address the BDS aspect of TTO, it seeks to support TTO’s operation, and therefore support their BDS indirectly.

2.3. Related Work

This section will look at a number of key areas of this project and how other researchers have approached these areas in work relating to microenterprises.

2.3.1. Target User Group

When introducing new technology, the choice of target user group is not always obvious. Researchers have tended to have one of three groups of people use the system: the microenterprises themselves, staff from an NGO, or a third-party consultant. This decision affects later choices such as the choice of technology platform.

A number of systems are used by the shops themselves such as the Frogtek system (Frogtek, 2010), the Bottom Billion Architecture (BBA) (Dörflinger, 2010) and United Villages (Hasson, 2010). An advantage here is that the shop owners become a part of the technology system that supports or replaces the previous systems. They remain included in the network of relationships that they were in before the new systems were introduced. The difficulty in building a system for shops is that there will be a wide variety of devices to cater for, and a wide variety of user requirements. One shop owner might be experienced with digital technology and own a smartphone while another shop owner might not even own a mobile phone.

There are benefits in hiring a third-party consultant to use the technology. Pradan (Ratan, 2007) introduced third-party accountants called *munshis* to interface between the NGO and the NGO clients. This allowed the process to remain the same for Pradan’s clients, making for a relatively undistruptive system change. For Pradan, the third-party consultant performed the menial work and allowed the Pradan staff to focus on more important areas of work. In this case, the consultants took over work from the NGO staff. In the case of the BBA (Dörflinger, 2010), a middle-man was required to collate shop

orders and actually order the goods from the suppliers. Here, the third-party was doing new work, rather than taking over work from others. An advantage here is that a technology platform can be prescribed without forcing shop owners to invest in devices, reducing the variety of devices that need to be developed for. Trust concerns from both the shops and the NGO may play a role in including a third-party in the system. For the shops, they may find it difficult trusting a new person with the details of their business. From the NGO's side, they may find it difficult to trust the quality of work from the third-party.

Another option is for the NGO staff to use the system, as was the case for Parikh et al. (Parikh et al., 2006). As with the third-party consultant case, the technology platform can then be prescribed without requiring the shops to invest in devices. This allows for more focused development and would typically reduce the number of users, and therefore reduce the variation in user requirements. If all the users are NGO staff, it also makes user requirement and evaluation meetings easier to set up because the staff can just be informed of the meeting. When working with shop owners, any time spent gathering requirements or performing evaluations is time that the owner loses at his business. In Parikh et al.'s case, although the NGO staff used the system, the long-term goal was for the self-help group (SHG) members to use it themselves. At the time of writing, it seemed as though this part of the work had not yet been done, so the effects of this on the final design of the system are unknown.

There are definitely benefits in having NGO staff or a third-party use the system. This approach doesn't interfere with the shops during development. It also allows for one device to be used, rather than trying to develop for the range of devices that shop owners may have. In most cases, it also supported the existing relationship and process between the NGO and the shops they work with.

A major drawback though is that when a shop owner needs to do something that requires the system, an NGO staff member needs to do it. This may require staff who are set aside to work primarily with the system. As the number of shops increase, more of these staff would be required though.

The literature suggests that developing a system where the NGO staff are the users is easier, creates a sense of ownership and maintains relationships rather than changing them. However, this choice will be expanded on later in the thesis when taking into account TTO's desire and in seeking to empower them further.

2.3.2. Technology Platform

There have been many approaches taken by researchers when trying to decide what technology platform would be most suited to their various circumstances. Most of the approaches have the users using mobile phones, sometimes augmented by the use of computers from a third party.

In Pradan's computer *munshi* case (Ratan, 2007), the process was extended by adding a third-party with access to a computer, while no technology was added for existing members of the system. Neither the NGO nor the shops they work with needed to purchase new technology. The application of job-seekers wanting to work as the third-party would have provided a filtering step so that only those with computers would be accepted. This would have screened for users who already had access to the

technology platform, and were somewhat accustomed to using it. The same is true for the third-party computer users in the BBA (Dörflinger, 2010).

United Villages and the BBA relied completely on mobile phones at the shop owner level. Since most shop owners have access to a mobile phone, and are experienced in using them (Donner, 2009a), this is a very reasonable requirement.

Frogtek (Frogtek, 2010) goes to the opposite extreme and requires shop owners to have an Android mobile phone and access to a computer. Perhaps this is a reasonable requirement for shops in Latin America, but it would be an unreasonable requirement in Africa since a large portion of the population does not have access to a computer (ITU, 2010).

Parikh et al. were looking to introduce technology to replace or augment an existing paper-based system (Parikh et al., 2006). They discovered that many of the people involved in the paper-based system were manual laborers and accustomed to handling tangible objects. They were also functionally illiterate when it came to technology use. For this reason, Parikh et al. felt they could not remove paper from the system, so instead they augmented the paper system with the use of mobile phones. The mobile phones were essentially used to data-capture the values on the paper forms.

Based on related work, the mobile phone is the clear platform of choice, with augmentations such as computer use and paper form use when required in the situation. This is therefore the target platform for this system.

2.3.3. Data Transmission Channel

Three very common data transmission channels are the voice, SMS and data channels. There are many examples of systems that use the voice channel, largely in market information services, as described in section 2.2.1. Voice chat is generally relatively expensive and slow compared to the other transmission channels. This leaves the SMS and data channels.

Many systems use the SMS channel (Hasson, 2010) (Parikh et al., 2006) (Dörflinger, 2010), however most of these are situated in India. In India SMSs are very cheap compared to data (0.16c per SMS and 32c per MB data) (Videocon, 2011) (Price India, 2011) so many Indian projects go with this channel.

In South Africa the opposite is true, where data is relatively cheap compared to sending SMSs (80c per peak SMS, 35c per off-peak SMS, and R2 per MB on prepaid) (Vodacom 4U, 2011) (Vodacom MyMeg, 2011). The BBA project was situated in South Africa, but still decided to use the SMS channel. This was probably to allow any users to use the system without needing to download an application for their mobile phone.

In South Africa, SMS favours accessibility since anyone can type an SMS using any mobile phone while data favours cost. Since the intended application will handle information communication rather than users being required to manually type an SMS, the data channel was used to communicate information for this project.

2.3.4. Introducing a Man in the Middle

In a number of systems, a “man in the middle” was introduced when technology was added to help facilitate the new systems (Ratan, 2007) (Dorflinger, 2010). They used some part of the new technology system and interfaced between the shops and the NGO or wholesalers.

It is very important to consider the various stakeholders in existing systems before introducing someone new. Adding a man in the middle would remove some existing relationships and would create some new ones. Stakeholders may resist this change, especially if existing relationships are longstanding and valued.

It is interesting to note that in the case of Pradan, it was the NGO (a major stakeholder) that pushed for the middle man. In the BBA, the middle man was introduced as part of a totally new system, so few existing relationships would have changed. In neither case was a middle man introduced against the will of the stakeholders.

This decision affects the employment of staff and is not a decision that can be made without engaging the stakeholders. Since this issue is largely related to the desires of the stakeholders, it will be expanded upon later in the document once the desires of the stakeholders have been covered.

2.3.5. Mobile Data Collection Systems

Open Data Kit (ODK) (ODK, 2011) and Openrosa (Openrosa, 2011) are existing mobile data collection tools. Openrosa describes a set of standards to promote interoperability of data collection tools. ODK provides a system for creating and synchronizing forms between an Android mobile phone and a backend server.

ODK is a substantial system providing more functionality than this project seems to need, and requires Android devices. Whether these tools or a more light-weight solution was required depends on the desires of TTO and the nature of the stock-ordering system.

Having considered the literature and works relating to this project, a mobile application was developed that uses a data connection to enable NGO staff to capture data and relay send it to the NGO.

3. Methodology and Methods

The design of many systems and objects is often done from an expert’s point of view, without considering how appropriate they are to a user’s needs and capabilities. Even if the designer is trying to be sympathetic to the needs of a user, they often misunderstand those needs. User-Centered Design (UCD) is a methodology that addresses problems of inappropriate or ineffective design (Jones and Marsden, 2006). This leads to usable systems, which augment users and address their needs directly. It is an iterative methodology employing many methods in order to understand a user, their context and create appropriate designs. In particular, we believe that UCD is appropriate for our situation for the following reasons:

1. User Requirements and Abilities are Ill-defined

In circumstances where user requirements and user capabilities are poorly understood, Participatory Design (Jones and Marsden, 2006) (Abrams et al., 2004) methods are appropriate. Participatory design encourages dialogue between the user and the designer to produce a system that is usable and understandable by the user. There are some associated advantages and disadvantages but it is widely accepted as a valuable methodology (Muller and Kuhn, 1993).

Where user capabilities do not allow for direct use of a technology system through illiteracy or financial constraints, Mediated Interaction (Sambasivan et al., 2010) provides a solution. With Mediated Interaction, an intermediary user interacts with the system on behalf of the beneficiary of the system. This allows the benefits of such a system to extend further than those who are able to use the system first-hand.

2. The Process is Poorly Understood

TTO's processes and work needed to be better understood to make a valuable contribution. Speaking to managers and to workers is important but insufficient in understanding their processes because some aspects tend to be overemphasized while others tend to be underemphasized. Contextual Inquiry (Beyer, Holtzblatt, 1999) is an appropriate method for discovering the details of processes and the reasons behind the actions. The focus of Contextual Inquiry is on the people involved in the processes. Another method that helps one to understand the details of document processes is Document Ethnography (Harper, 1998). This focuses more on the documents that are the output from a given process.

3. The User Interface must be Understood by the Users

The user interface of the system needs to be familiar or intuitive for the users. Users should not be expected to spend a significant amount of time learning how to use a system that does not make sense to them or fit with their working practice. To determine how closely a user's mental model of a user interface matches the implemented user interface, a Conceptual Model Extraction (Jones and Marsden, 2006) can be used. This also provided a list of specific aspects of the interface that will need improving.

Another method of evaluating user interfaces is Heuristic Evaluation (Nielsen, 1994). This evaluates aspects of the interface according to best-practices. This can help uncover areas where usability can be improved even if they do not hinder use normally.

3.1. User-Centered Design

UCD is a broad methodology that describes design processes in which end-users influence the design. There are many methods associated with UCD with varying degrees of involvement from the users, but the important point is that the design process revolves around and includes the end users.

It is important to design with user requirements and desires in mind. The product should be usable as intended by the user, without much time spent learning to use it. Users are often involved in evaluation stages during the design of the product so that modifications can be worked in if necessary. The final evaluation is also focused on the user and how the product has matched the requirements and desires

of the user. In this sense, the user really is at the heart of the design, while the designer is facilitating the process. (Abrás et al., 2004)

Since users are involved in design and intermediate evaluation steps, Iterative Design follows naturally as a design model. This is in contrast to older, less agile models of development such as the waterfall model where there are three stages: design, implementation and finally evaluation. The Waterfall model relies heavily on a clear system specification before design commences because modifications in design become very difficult and expensive later in projects. Having user requirements up front is not always possible though. Iterative development is much more suited to incorporate these changes that arise when using a UCD methodology.

Unlike the waterfall method of development, iterative development revolves around development cycles. Each cycle typically consists of three phases: design, implementation and evaluation.

1. Design: Design according to the most recent requirements available, focusing on the users' priorities for the system.
2. Implementation: Implement the design as a computer program, support document, or information system as appropriate.
3. Evaluation: Evaluate the current implementation according to the design goals for this iteration. Including the users in evaluation will help in discovering further change requests and problems that arise.

Iterative development allows for quick adaption as user requirements are discovered and more clearly understood throughout the project.

UCD is a powerful methodology in any user-oriented environment. It is especially helpful when the designer has very limited knowledge of user desires and abilities. In such a case it is beneficial to discard inappropriate design ideas as early as possible so that the design can begin to converge to an appropriate solution.

Iterative development also supports "*fast fail*" (Jensen, 2002). *Fast fail* is when design ideas are quickly evaluated using low-fidelity prototypes in an attempt to explore many different options and discard those that show little promise. This allows the promising designs to be prioritized and receive more attention. Iterative development supports this because the purpose of the design, implement, evaluate cycle is to evaluate designs sooner than in other development models. This reduces the chance of poor design decisions being discovered late in development when changes are expensive. (Jones and Marsden, 2006)

UCD is an appropriate methodology to use to help understand user requirements, desires and abilities. Coupled with iterative development, UCD allows for flexible, adaptive design that seeks to produce a system that fits the users rather than teaching the users to fit the system.

The wider field of Human-Computer Interaction (HCI) contributes a number of methods towards a UCD approach, such as Participatory Design, Interaction Design and a number of evaluation tools. These tools

and methods must be adapted for use in developing-world contexts however, to accommodate the social and cognitive differences present in users (Ho et al., 2009) (Medhi, 2007). An example of this is in India where strict social ordering prevents users from giving honest feedback about systems to researchers (Chavan, 2005) (Medhi, 2007). This behavior has been noted in the African context also (Gitau et al., 2009). The body of research that investigates this application of HCI methods to developing-world contexts is known as HCI for Development (HCI4D). Therefore, in our application of these methods we will reflect on their appropriateness in a developing world context.

A number of UCD methods applicable in the context of this work will be described in the following sections, beginning with Participatory Design.

3.2. Participatory Design (PD)

In participatory design (PD), the end-users are not just involved in requirement gathering and evaluation but in the actual design of the product itself. The end-users become co-designers of the product. This places users and designers in much closer proximity than normal and encourages open communication about requirements, desires and abilities. It also helps users understand some of the difficulties designers face when considering design decisions.

Often the users and the design experts will have a different language for describing ideas. Because of this, participatory design tends to be very visual, incorporating lots of rough sketches and tangible objects. PD participants use low-fidelity items such as pens, paper and sticky notes to help facilitate the communication of ideas. Once the idea is visible on paper, it can be evaluated and modified quickly. Work-flows, systems and user interfaces can be more easily drawn and described using pictures when there is a language mismatch between user and designer. (Abrams et al., 2004) (Jones and Marsden, 2006)

In a developing-world context where users may have had little exposure to technology, they may be able to evaluate a design but not provide ideas for how to improve it. This requires creative methods to elicit feedback (Ho et al., 2009).

There are a number of advantages and disadvantages when using PD. These will be covered briefly.

3.2.1. Advantages

Because there is more ongoing dialog than usual between users and designers, PD puts both users and designers in a better position to identify requirements misunderstandings. In contrast, if users are only introduced to the system during evaluation, it may become apparent that the way the end-users follow a process differs from the way the management understands the process. (Abrams et al., 2004)

Since the users are involved in the development of the system right from the start and get to see how it changes and grows, PD also encourages the users to take ownership of the system. It allows them to be a part of the unfolding story and to see how their ideas have been taken into account. (Abrams et al., 2004)

Users being a part of the developing system has benefits other than a sense of ownership. It also helps with expectation management, because the users have been aware of what the system is capable of from an early stage. (Abrams et al., 2004)

The final product is also more likely to match the users' conceptual models of the system. During development, users will be able to question and improve on ideas that seem confusing, rather than right at the end.

3.2.2. Disadvantages

These benefits do come with some cost though. PD requires time and effort to get input from users and for users and designers to begin to understand each other. PD also often involves a wider selection of stakeholders, rather than just the management. This can be a deterrent from using PD because some people consider the cost to outweigh the benefits (Preece et al., 2002).

When users are thinking of ideas for a product, they may not always be aware of what is possible. This may limit their design ideas because they may only think in terms of technology they've seen before.

Users may also have biases towards a particular design that leads to sub-optimal solutions. An example might be of users wanting to use a particular mobile phone they like as part of a technology product when the mobile phone is not particularly suited to the task.

Despite some of the disadvantages, PD is a powerful approach in design and lends itself to working in an ICT4D setting where user requirements and desires are not always easy to determine.

3.3. Design Methods

This section will describe the methods, most of which are associated with participatory design, which were helpful in addressing the design challenges of this project.

3.3.1. Participatory Design Workshop

PD lends itself to prototyping in a workshop or focus group setting with designers and end-users present. Pens, sticky notes, marker pens, paper and other office stationery are used to make it easy to get an idea down. A facilitator can lead the workshop to introduce PD to the participants and to encourage participants to start putting ideas down on paper. Participants then listen to and evaluate design ideas given by individual participants. Since designs are expressed mainly on paper and using sticky notes, new ideas can be drawn and sticky notes can be moved. This allows ideas to progress quickly with fast, cheap, low fidelity prototypes. The low cost of a new idea or prototype also encourages participants to put ideas down, even if they are not confident. Once some design ideas have been settled on, higher fidelity prototyping can begin. The workshop facilitator can direct the focus of the workshop so that various aspects of the design are explored, such as looking at work flows and graphical user interfaces (GUIs). As with most workshop settings, the facilitator should also encourage ideas from quieter participants. (Jones and Marsden, 2006)

3.3.2. Conceptual Model Extraction (CME)

The purpose of a CME is to understand how a user interprets an interface or system. The user is shown a prototype of the system and asked what they think buttons or widgets are for. An alternative is to show

the user a prototype of the GUI and ask how they would go about performing various tasks. The way the users go about performing the tasks and the responses they give are recorded. This gives insight into the way the users perceive the system and highlights areas where the users' conceptual model of the system matches the system design and where there are mismatches. The areas of mismatch can then be redesigned so that the model of the system fits more closely with the conceptual model that the user has. (Jones and Marsden, 2006)

Some people argue that CMEs are not worthwhile since users can simply learn how to perform functions that are not intuitive. This line of thinking contrasts with UCD. If users are expected to learn how to perform unintuitive tasks, that hardly places users at the center of design. One of the goals of UCD is to produce a system that is easily usable by users without having to spend significant time learning how to perform tasks. If you have a user-centered design, this line of thinking becomes inconsistent.

3.3.3. Contextual Inquiry (CI)

A method helpful in understanding a user's current set of work tasks is a CI. CI is rooted in a humble approach to understanding users. Instead of studying the users and their activities, the designer spends time with users and learns from them while they go about their normal work.

During a typical CI, the designer will spend a portion of time with a user watching them work. The designer takes note of how they go about performing tasks. When a particular practice is not understood by the designer, he interrupts the user and asks questions to try and understand the reasons behind the practice. The user then explains the reasons and gives insight on aspects that can be difficult to discover through other methods.

CIs have a number of benefits over just interviewing users. Because the designer is actually with the user during the working day, certain tasks are not over-emphasized or left out. CIs also help the designer to become familiar with the day-to-day aspects of the user's work, including how enjoyable, difficult and time-consuming various parts are. It is not uncommon to have disparities between the way a task is performed and the way a manager thinks it is performed. CIs help to understand what these disparities are and why they occur. (Jones and Marsden, 2006)

3.3.4. Document Ethnography

Document ethnography involves following a document from creation of the document until the end of its process. The researcher follows the paper trail from the document creation via all the actors that interact with the document at various stages until the document is discarded. This reveals what portions of the document are important to which actors and at which stages. Document ethnography is a useful tool in discovering how processes work. (Harper, 1998)

3.3.5. Heuristic Evaluation

Heuristic Evaluation is an evaluation method that informs design. For heuristic evaluation a group of usability experts will evaluate a system or user-interface according to a set of established best-practices. Design aspects that do not meet these best-practices are noted. This provides a focused set of areas where design needs to be improved (Nielsen, 1994).

The methods and methodologies relevant to this work have been described. CI and document ethnography were employed to investigate TTO's priorities and processes. PD was then employed to develop a system that fits TTO's needs and desires. To determine how good this fit was, CME was employed and highlighted changes that needed to be made. A heuristic evaluation was also performed to contribute to the design of the user interface. These all formed part of progressing design iterations.

An explanation of the iteration cycles of this project follows. The manner in which methods were carried out will be described and the insights gained through the evaluation steps will be highlighted.

4. Iteration One

The first iteration was primarily about discovering what TTO's priorities were. Once that had been established, the focus shifted to determining more clearly how the paper-based system works and what requirements there would be for a digital-based system. These tasks were approached using CI to help uncover the systems and practices in place. This involved meeting with two of the TTO managers in order to understand the context of the organization and spending time with the field staff. This formed the basis of the design. For the implementation a number of interface ideas were explored using prototyping, and were evaluated by the researcher.

TTO's needs and priorities could have been investigated through the use of use case narratives; however CI gives some benefits over just a verbal discussion, as noted in section 3.3.3.

Due to the time constraints of the project, an in-depth study of the spazas' individual needs and desires was not possible. The generalized needs of the spazas were implicitly conveyed through the mediated design process. This is also true of an in-depth study of the suppliers. Both studies are important and would be valuable given sufficient time.

4.1. Contextual Inquiry with TTO Management

The first meeting with TTO was set up through a PhD student who had had some communication with them for her project. After this introductory meeting, the meetings consisted of the researcher, the regional manager at TTO and the project administrator.

4.1.1. A Number of Ideas

Prior to the start of this work, TTO had expressed to the PhD student the desire to implement a mobile financial record-keeping system for the spazas they work with. This was therefore the initial expectation of the researcher for the direction of this project. Although there was an expectation about the direction of the project, the initial meetings were aimed at discovering what was most important to TTO.

Early meetings with management centered largely on two ideas: a mobile stock-ordering system and a mobile bookkeeping system. There were many other ideas mentioned briefly, such as producing a web-based job portal for job searches and CV management, using mobile phones as a training portal or as a crime prevention tool, but these were not given attention after their mentioning.

During the discussion around the two prominent ideas, much background was discovered in terms of TTO's operations, their interactions with the spazas, how the spazas operate and how profitable they are amongst other aspects.

4.1.2. Focusing on the Priority

When considering how much attention was given to each idea, it became clear that the two top priorities were the mobile bookkeeping system and the mobile stock-ordering system, but it was not clear which was most important. It took approximately four months from the initial meeting to settling on a list of priorities and an idea for the SHOP-Net system.

While discussing a mobile bookkeeping system, a bookkeeping pilot study was mentioned. TTO had run a pilot course with the spazas to encourage them to record details such as sales, cost of sales, stock purchases and drawings on printed paper forms given to them. The pilot was met with apathy from the spazas and none of them requested new forms after receiving the first set. Many of them did not even make use of the first set.

TTO seemed to be steering the discussion towards the mobile stock-ordering system. This may have been motivated by the disappointing turnout of their bookkeeping pilot study. The researcher, on the other hand, seemed to be steering the discussion towards mobile bookkeeping based on the early expectations given by the PhD researcher.

When TTO was asked what their top five priorities for the system were, all of them related to mobile stock-ordering. It was then settled that this would be the direction for the project. The ordering process as it stood was then explained in much more detail by TTO. This will be outlined in the following section.

4.1.3. The Stock Ordering Process

The stock ordering process primarily involves three groups of people: the spaza shops, the field staff and the administration staff.

4.1.3.1. What the Spazas Get

The stock ordering service TTO provides is called SHOP-Net. SHOP-Net stands for Spaza House-shop Owners Partnership Network. SHOP-Net is how the service is branded to the spaza shops.

Since many shops order stock through SHOP-Net, TTO is able to buy in bulk and achieve lower prices than individual shops would be capable of. This allows the shops to purchase most items from TTO at reduced prices. Some items might still be cheaper from other suppliers though. If the spazas are aware of this, they will purchase those items through the cheaper suppliers. If they are not aware of it, the TTO field staff will advise them to do the same. TTO sources prices from up to four suppliers, so spazas get the lowest prices from a number of suppliers.

Once a month, a catalogue of items and prices is mailed to each spaza. For each item there is a picture of the item, the name and the price. Depending on how frequently a spaza orders stock, a TTO field staff member will visit the shop up to twice a week to take orders, and down to once every second month for spazas that order infrequently.

The spazas almost always pay for their stock late, that is, after the stock is delivered. In more developed economies, one usually pays for goods before receiving them, but in a different cultural context, the assumption is different. The spaza shop owners want to see the goods before they pay for them. Their view as described by TTO is, “why should I pay for something that I haven’t got yet?” For this reason, the spazas have an account with TTO to ensure that they do pay once the goods are received. The credit limit allowed by TTO to each spaza depends on the payment history and size of the shop. Some spazas don’t manage to clear their debt for months at a time, but there is a trust relationship between TTO and the spazas and they do end up clearing their debt over time. Each spaza is sent an account statement once a month with the new item catalogue.

For each stock order a “transaction fee” is charged, based on the monetary value of the order. This is to cover stock delivery costs. The way the transaction fee is structured also hinders shops from making many small orders. See Appendix A for transaction fee prices at the time of writing.

Once the stock has been ordered it is almost always delivered the next day if there are no problems. The stock is delivered directly to the spazas by the suppliers that TTO purchases from.

Apart from the stock ordering, the spazas also receive business advice. When a field staff member comes to collect orders, there is usually some informal chatting between them and the *spaza* owner before the order is taken. The field staff member usually asks how business is going and then gives some informal advice or encouragement as seems necessary. From time to time TTO will host a formal training session that spaza owners can attend.

4.1.3.2. *The Role of the Field Staff*

At the time of writing, there were five TTO field staff members. Each one is responsible for overseeing between nine and 29 spazas which are usually situated in the same area. They are responsible for visiting each spaza to take orders. The frequency of orders depends on the spaza so not all spazas need to be visited every week. The field staff members go out to collect orders twice a week, on a Tuesday and a Thursday.

Field staff are also responsible for collecting payment from the spazas for stock orders. Money for an order is often collected at the same time as a subsequent order is taken. Sometimes a field staff member will get to a spaza and just collect money if there is no order to be taken.

Before, or while an order is being taken, the field staff member will chat to the shop owner and find out how the business is going. Advice will be given as described in section 4.1.3.1.

The orders are taken down in order books containing one order sheet per page. On the order sheets are blank fields for the spaza’s client number (a unique identifier given to each spaza when registering with TTO), the name of the owner, the shop name, and a contact number. Typically, only the client number is recorded because the other details can be determined from that. The order is then recorded by filling in the requested quantity next to each item name. See Appendix B for a sample order sheet.

Once all the orders for the day have been collected, the field staff members all drive back to the TTO offices. Each field staff member's order sheets are given to the administration staff to be data-captured and collated. While this is happening, the field staff members reconcile the cash they received during the day with the accounts of the spazas they received it from. There is a general discussion meeting for the field staff on Tuesday and Thursday afternoons to discuss how the day went and address any problems that arose.

For the remaining three days of the week the field staff are involved in recruiting new shops to sign up with SHOP-Net, collecting payment for orders, and offering business advice to spaza owners.

4.1.3.3. The Administration Staff

There were two administration staff at the time of writing and they had a number of roles relating to stock ordering on Tuesdays and Thursdays. In the mornings, while the field staff are out collecting orders, the administration staff are usually busy on the phones. They process requests made by the field staff, such as asking for an opening balance of a spaza or to calculate an order total. The field staff members will often phone the TTO office and ask one of the administration staff to phone them back, placing the cost of the call on TTO rather than on the field staff member's personal phone bill.

The administration staff would also take a number of "phone orders" during the morning. A spaza would be called via their mobile phone and asked what stock items they would like to purchase. The list of stock items would be communicated while the administration staff member recorded it. The spaza owner would be asked if the order total was acceptable and, if so, the order would be placed as per usual. Of course, no receipt would be given for this order. The relevant accounts would be updated and the cash received at a later date by one of the field staff. At the start of this project up to half of the orders were taken over the phone.

From about 2:30pm, the field staff start arriving back at the office with their order forms. There are usually between 25 and 35 order forms per order day totaling between R10 000 and R30 000 in value. Once the first batch of order forms arrives, the administration staff begin data-capturing. For each form the stock items are input into the accounting package and the spaza's account is updated. The data is then exported to Microsoft Excel and printed from there. Once all the order forms have been data-captured, the collated orders are sent to the suppliers of the goods.

The suppliers close for orders for the day at 5:00pm so the data-capturing process is often a rushed one. TTO has an agreement with the suppliers to allow orders to still be placed after the suppliers' official closing time. If the orders are submitted early enough, they stock is packed and ready for delivery by morning. If the orders are too late, the stock might only be ready for delivery the next afternoon or even the following day.

Along with the stock orders, the administration staff also record the amount of money received from spazas for stock. The money is brought in with the field staff with the orders. For each spaza that paid money that day, their account is updated.

On Mondays, Wednesdays and Fridays the administration staff attend to other administration work.

Figure 1 summarizes the order process:

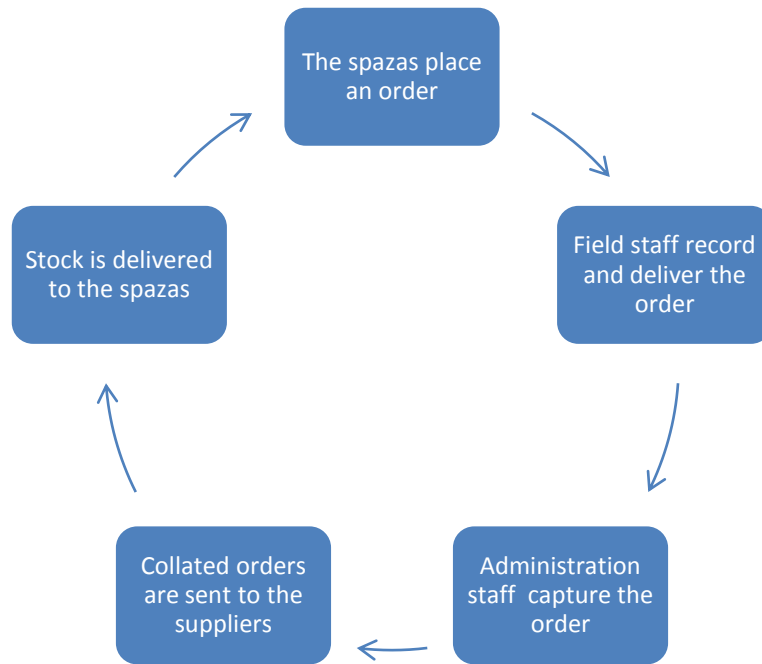


Figure 1 – The Stock-Ordering Process

The actual order form is validated in the following way, described by Figure 2:

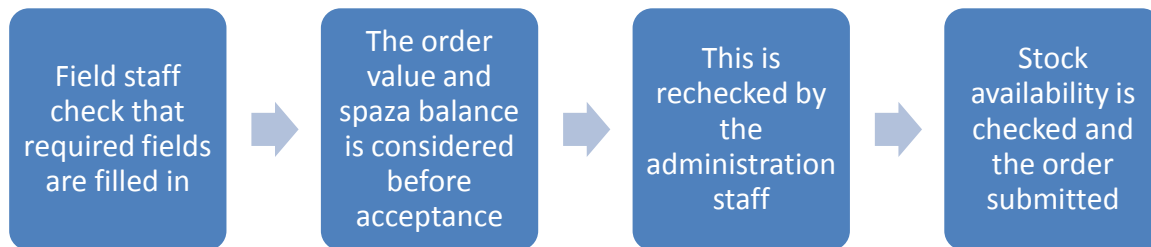


Figure 2 - Order Form Validation

Along with the description of the stock-ordering process, TTO also described some problems associated with the process.

4.1.4. Problems with the Current System

There were a number of problems and inefficiencies with the stock ordering system as it stood. They are as follows:

4.1.4.1. TTO Office to Spaza Distance

The TTO office is situated in an urban area, less than six kilometers from the city center while most of the spazas are situated between 25 and 35 kilometers from the city center. The round trip for the TTO field staff is between 60 and 100 kilometers, making it a costly one considering that up to twelve such trips are made per week.

4.1.4.2. Order Sheet Inflexibility

The order sheets have approximately 250 stock items per page, making the text relatively small. The stock item prices are not printed on the order sheets due to a lack of space and price changes being more frequent than the books are printed.

4.1.4.3. Lack of Easily-Available Information

To calculate the total of an order, the price catalogue is used with the order sheet to determine the order's sub-total. For each item in the order, the corresponding item price is found in the catalogue and multiplied by the quantity. This is done by hand with a calculator if one is available. If no calculator is available, a mobile phone call is made to the office. The order is dictated over the phone to the administration staff member who then calculates the total and tells the field staff member. A mobile phone call is made to the office to ask what the associated transaction fee is depending on the subtotal.

Due to this being time consuming and expensive with mobile phone calls, the total is often not calculated. Both the spaza owner and the TTO field staff member have some idea of what the total is and whether the spaza is capable of paying for the stock or not. The field staff member will decide whether the order is too big or not.

Field staff members do not typically have spaza shop balances with them. To find out what a shop's balance is with TTO, the field staff member would need to make a mobile phone call to the office. This sometimes informs the decision whether a spaza is allowed to order more stock or if they need to clear some debt before making new orders.

This also means that the spaza owners are not entirely aware of their outstanding balance with TTO after an order is placed. Each spaza would typically only see their balance again when their account statement is sent out at the end of the month. It is possible for spazas to keep track of their balance by keeping a record of their orders and payments but record-keeping is not a high priority for most spazas. They are usually happy to just wait and see what the balance is at the end of the month.

4.1.4.4. Workload Spikes for Administration Staff

Data-capturing orders is a time consuming process. The order forms only start arriving with the field staff at around 2:30pm, and continue to arrive until about 4:00pm. The aim is to always have the forms data-captured and sent to the suppliers before they close for orders for the day at 5:00pm. This is not always possible.

The arrival of batches of forms means that the admin staff's workload suddenly spikes. There is almost no preparatory work to be done beforehand so order-related work can only begin when the forms arrive. As soon as they do arrive it is a rush to try and process a batch before the next batch arrives and before the suppliers close for orders. This rush continues until all the forms have been processed.

The arrival of money with the order forms adds work at an already busy time. Each account update requires only two pieces of information, the amount paid by and the name of the spaza. At the moment, this information only becomes available to the administration staff when the field staff arrive back.

While the order forms are being captured, all other administration work is suspended. All of this work can only be done in a 150 minute window on Tuesday and Thursday afternoons. This is by far the administration staff's busiest time and is the cause of significant pressure and stress on those days.

4.1.4.5. Reconciliation for Cash Received

When the field staff collect payment for orders from the spazas, they are supposed to issue a receipt, which would serve as a payment record for both parties. However, they don't always record what amount they received from which spaza. Sometimes they will arrive back at the office in the afternoon with a sum of money but will struggle to remember which spazas paid what amount. Sometimes they are able to remember and reconcile the amounts but other times mobile phone calls need to be made to a spaza owner to check amounts paid.

Apart from the mobile calls being expensive and unnecessary, this also allows for errors because a spaza owner might not remember how much they paid either. It also allows for dishonesty if a spaza owner claims to have paid more than they have. Dishonesty was not mentioned as a problem by TTO, but the opportunity exists.

4.1.4.6. Phone Orders are Costly

When the administration staff take phone orders, the calls are almost only to mobile phones. These calls can take up to 15 minutes. With mobile phone costs as much as R2.75 per minute (Vodacom 4U, 2011), phone orders can cost up to approximately R40 each.

Once the ordering process had been understood, the discussion around who the users would be began.

4.1.5. Target Users

The three reasonable options included the spazas themselves, the field staff, or a third-party consultant. A third-party consultant was deemed unnecessary since the field staff already visited the spazas. After some discussion, it was still unclear which was to be the more suitable option between the field staff or the spazas using the system. It was decided that, in the long term, it would be ideal to have the spazas themselves using the system, but in the short term, it was less risky to have the field staff using the system. This would also allow the backend of the system to be tested through usage before increasing the complexity with spazas beginning to use the system. It was decided that the field staff would use the system.

During the discussion weighing up these options, many usage ideas and potential benefits were considered. These will be discussed in the following section.

4.1.6. Functionality Ideas and Benefits

During the CI with the TTO management, they suggested ideas for what they would want in a mobile stock-ordering system. These ideas were mentioned over a number of meetings are collated here. The basic idea they gave for the mobile stock-ordering system is that users, the field staff in this case, would be able to place orders using a mobile phone and send the orders to a server at the TTO offices. Stock prices would need to be integrated into the ordering process while being able to update the prices remotely from time to time. Spaza account balances would need to be fetched from the server based on

their client number. Orders would also need to be totaled with the transaction fee calculated automatically. The amount of cash received from the spazas in payment of their accounts would need to be recorded and the closing balances calculated and made available for the field staff and the spaza owners to see. The server would also need to generate invoice numbers for orders received electronically. Figure 3 outlines the basic functionality ideas:



Figure 3 – Basic Functionality Ideas

During the meetings with management, TTO was very open about the flaws in their paper-based system (as described in section 4.1.4). If addressed, these would become benefits of the SHOP-Net system. Table 1 lists the expected benefits in order of importance as expressed by TTO:

Table 1 - Expected Benefits

1	That the field staff would be more efficient, including: <ul style="list-style-type: none"> Reducing the amount of driving Reducing the number of mobile phone calls made to get spaza information
2	That the administration staff would be able to receive order and payment information earlier in the day
3	That the spazas would take more notice of balances and account information on a mobile handset than paper due to an expected increased sense of professionalism

4.1.7. The Platform Decision

The SHOP-Net system would need to be delivered on some sort of digital platform. The three primary candidate platforms were mobile phones, laptops and tablets such as the iPad or the Samsung Galaxy. Since the price of tablets is comparable to the price of laptops, but with reduced size and reduced ability to be used as general purpose computers, tablets were ruled out.

In the long run, if the system was to be used by the spaza owners themselves, then laptops would be an inappropriate platform choice. TTO also raised safety concerns about their staff using laptops in township settings.

It was thus decided that the system would run on mobile phones. Since the system was going to be used by the field staff, the mobile phones were not limited to just feature phones but rather to whatever handsets TTO wanted to use. In an early meeting, the main TTO manager had said how nice it would be if their staff could be using smart phones and be able to easily check their email out in the field and how

professional they would look. Cheaper mobile phones are generally viewed as more appropriate in developing world contexts to reduce the barrier for new users. Since TTO would be responsible for providing their staff with the phones, the extra costs of using smart phones was felt to be outweighed by the expected benefits of using them.

There were a number of smart phone options available such as the iPhone and various Android, Blackberry, and Nokia handsets, however the Android phones seemed the most promising option.

There is a wide range of Android-based handsets, which has produced a wide range of prices. This would allow TTO to prioritize cost and get cheap handsets such as the Vodafone 845 for approximately R1400 (Cellucity, 2010), which seemed to be the cheapest smart phone available in South Africa at the time. They could also prioritize usability and quality and get more expensive handsets such as the Samsung Galaxy S. Because of these price options, the rapidly growing number of Android devices, the falling costs of the devices, and the ease with which applications can be developed for a range of Android-based phones, the researcher suggested the use of Android handsets, to which TTO agreed.

Along with the pros, there are also cons associated with Android phones, however most of these are negative features of smart phones in general. Examples of these features include the relatively high price compared to feature phones, and the greater risk of theft due to the increased value of the devices. These negative features were acceptable to TTO when considering the advantage of using the devices.

Since Android handsets will be used, ODK needed to be considered as a potential tool. ODK is more heavy-weight than is required for this system. Since a PD approach is being adopted, ODK would need to be modified to fit the design. This modification may take more effort than just creating a light-weight solution tailored to TTO. Using XForms, as required by Openrosa will also add unnecessarily to the volume of data required, unless the intent is to interface this with other data collection systems. This does not seem the case, so ODK will not be used.

There was a concern from TTO that spaza owners may think that mobile phones are only for making calls if this work was extended to put the phones in the hands of the spaza owners. Due to the reasonably widespread use of mobile applications such as Mxit (Mxit, 2011) in South Africa and a general increase in mobile internet use across Africa, this concern is not likely to have a big impact on future work and would be something worth investigating if the situation arose.

4.1.8. Expectation Management

Expectation management is an important part of any software-related project. This is also true for ICT4D projects (Anokwa et al., 2009), especially because NGOs are often reluctant or unable to spend large amounts of money on software.

Apart from the ideas relating to the SHOP-Net system, TTO made a host of other requests of the researcher. These include remaking their organization website and either setting up a network for TTO, developing a basic curriculum for training high school students in computer literacy or creating a job portal that includes CV maintenance and job search tools.

This provides a good example of an NGO trying to bargain as much out of the project as possible. It is better to make small promises and deliver more than expected than it is to make big promises and then not meet them. In an attempt to build a relationship with the NGO and encourage enthusiasm, it is easy to create more hype than what a researcher can deliver over the period of a project (Anokwa et al., 2009). This can lead to disappointment later when the researcher fails to satisfy an unreasonable list of objectives. For this reason, it is important to be reasonable and clear about what is possible during the timeframe of the project. This may create some initial disappointment, but will make the successful delivery of the high priorities more likely.

In this project, that meant declining those requests that were not related to the SHOP-Net system. Some time was spent researching free website tools, but apart from that the focus remained on the SHOP-Net system.

Having said that, it is a difficult task trying to establish what the main focus is and what the peripheral goals are. It is not always clear what the priority is. For instance, the stock-ordering system seemed like a side-issue at first, but was then realized as the main priority. The reason it was difficult was because the TTO management had many ideas and seemed to get excited about most of them. It was important in this project to settle on a priority list before committing to doing particular tasks. While there are a number of methods of gathering priorities from users, their effectiveness is diminished when the bounds on resources are still being established and the users are undecided as to what is most important in their context.

4.2. Contextual Inquiry with the Field Staff

Once the priorities had been established and the project focus had been decided, it was important to begin to understand the users and their tasks. A CI is a suitable method for doing this and was performed over a two day period with the researcher following two field staff through a typical stock-ordering day. Whilst Contextual Inquiries typically take a much longer time, there were large restrictions on the availability of the staff. So whilst the initial CI was short, the staff were engaged in short intervals over a period of many months to ensure that a correct understanding of process was reached. This initial CI served only as a starting point from which to grow our understanding.

Both days began with the researcher meeting the day's field staff member in situ. From there, each spaza that the field staff member was responsible for would be visited. Sometimes orders were taken, and sometimes there was just some conversation between the spaza owner and the field staff member.

The orders typically began with the field staff member recording the spaza's client number from memory and the date using a pen and the order book. Some spazas would hand them a written list of items while other spazas would look around their shop and decide what items to purchase while they recorded the items. Little consideration was given to the total of the order, but the field staff and the spazas had a hunch of how large an order could be. Once the order was agreed to by both parties, an invoice would be issued and parting greetings said. The field staff would then drive to the next spaza.

During this ordering period, general conversation took place between the spaza owner and the field staff member. Part of this conversation would include the field staff member asking how business is going and responding with advice if it seemed helpful.

Once all of the spazas for the day had been visited, the field staff member and the researcher returned to the TTO offices to deliver the paper order forms. During the ordering time, attention was given to the details of the ordering process and to the interaction between the field staff member and the spaza owner.

During the CI it became apparent that information from the management about the ordering process was accurate but incomplete. Walking through the process step by step with the field staff demonstrated the importance of various aspects of the process and helped to frame practices, especially those that had been over or underemphasized.

An example of this is that only the client number, name and date are recorded on the order sheet even though the sheet has extra fields for shop name and contact number as well. Another example is when there are new stock items that aren't printed on the order form yet, they get hand-written at the bottom of the page.

The CI also allowed for a walkthrough of the paper form lifecycle, from the orders being recorded until they were handed to the admin staff to be data-captured. Working through the ordering process allowed for a practical document ethnography.

4.2.1. The Ordering Process

The typical order would be placed while the spaza owner and the field staff member paced around the store looking at the items that were missing or low in quantity. The order would be taken and agreed upon, usually without totaling the order. The spaza owner would receive a carbon copy of the order and sometimes a receipt if the order had been totaled.

It was interesting to note that some shops used the order form from the previous order to fill out a new order before the field staff member got there. It was not that they used their previous order quantities to inform the next order quantities, but rather that the order sheet provided a physical list of items that could be written on. . This would not be possible with a digital ordering system as no physical page is given to the spazas on which to write. There were also spazas where the owner handed the field staff a written list of items on a torn piece of cardboard upon arrival.

4.2.2. Interactions

Apart from the ordering process, other interactions between the field staff and the spaza owners were noted. The importance of the conversation between the spaza owners and the field staff during the ordering process became apparent. During these conversations, the field staff gave encouragement and informal advice and training. The TTO management expressed this as one of the main functions of the field staff, and yet this function is carried out in an informal manner. If a digital system hastens this interaction, this informal conversation might be affected.

The presence of the researcher had some effect on the interaction between the field staff and the spaza owners. During the CI, one of the spaza owners commented that the field staff member was being unusually harsh in asking for a payment. Another spaza owner asked what the new system would do for him. The field staff member began to make expansive claims about system functionality, having not been involved in any discussion about the system.

The last important interaction was between the field staff members and the researcher. Spending a day with the field staff allowed for relationships to be built. These relationships created more of a sense of collaboration rather than an outsider performing research at TTO.

4.3. Prototyping

Once the initial meetings with the TTO management and the CI had been completed, the technical aspects of development needed investigation. A number of prototypes were developed in order to gain familiarity with Android and the associated tools available. This would also reveal what is technically possible, allowing the designer to steer the PD workshop away from design ideas that are infeasible or impossible.

Prototyping also acted as a tool for engaging with, and thinking through the design problems. Klemmer et al. (Klemmer et al., 2006) describe how designers think about design problems through prototyping. Prototyping provides a tangible method of engaging with a problem rather than just a cognitive consideration of the problem. Schön (Schön, 1983) describes how designers can evaluate and frame a problem through a series of prototypes using Reflective Practice.

These prototypes began with low-fidelity prototypes using pencil and paper and sketching various feature layouts with different screen orientations, as seen in Figure 4 and Figure 5.

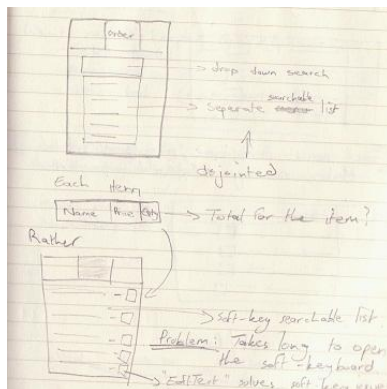


Figure 4 – Paper Prototype 1

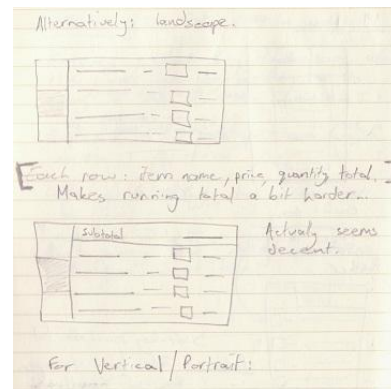


Figure 5 – Paper Prototype 2

The most promising design was coded into a higher-fidelity prototype. This did not fit easily with the Android interface structures and resulted in buggy code and a clumsy system to use.

These prototypes were never shown to TTO staff to avoid priming them before a PD workshop. This allowed their design ideas to be uninfluenced by the designer's own ideas.

The order process had already been discovered, but just having the process is not enough to build a usable user interface. At this stage, it was beneficial to employ PD. Working together with the users to discover what their interface priorities were was helpful. This informed decisions about which lists or input fields would be most frequently used and be most prominent. Prototyping continued until the PD workshop was conducted to allow for continued Reflective Practice.

CI had begun with the TTO managers and the field staff. The managers helped in understanding the priorities of TTO and in deciding on the direction of the project based on those priorities. They also described the stock-ordering process and the associated problems with it. Expectation management was an important theme during these early stages of the project. CI with the field staff helped in understanding the interactions between them and the spaza owners and added to the understanding of the stock-ordering process. Android was also being investigated in order to understand the software environment and to provide a prototyping tool through which the designer could reflect on the problem.

5. Iteration Two

In order to improve the user interface design, input and direction from the users was needed. A workshop was carried out to encourage PD and collaboration. Over the same period of time, the back-end of the system was implemented to provide functionality to the user-interface. The user interface prototypes would serve as a code-base onto which the ideas coming from the PD workshop could be built.

The intention of the PD workshop was towards Co-Design between the field staff and the designer. Co-Design is an important tool to use for the same reasons PD is, and has been shown to be effective in developing-world settings (Ramachandran et al., 2007). The TTO field staff all use computers and cell phones. This overcomes one of the barriers to UCD in general, and PD in particular, where users are unfamiliar with technology and are unable to make contributions towards design (Marsden et al., 2008).

5.1. Participatory Design Workshop

The PD workshop included all five of the field staff and the researcher. The administrative head also joined in. It was scheduled for the end of an order-collecting day because all the staff would be at the offices already. Since many of the field staff had not used smart phones before, some examples of Android user interface widgets were printed out to give the field staff an idea of what was possible. Figure 6 shows some of these widgets:

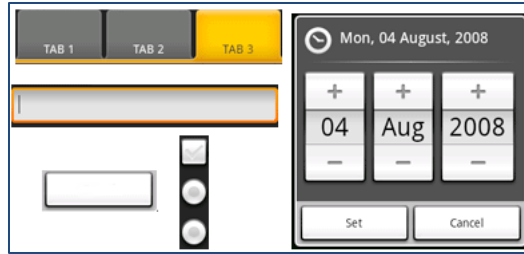


Figure 6 – Example Android widgets used in the PD Workshop

At the start of the workshop, it was explained to the field staff that their input was important in designing a system that would be easy for them to use. The goal of the workshop was described in terms of collaborating on an interface design and the method was explained in terms of using office stationery, paper and sticky notes to put ideas down. To encourage ideas from all participants, the field staff were each asked to individually sketch an idea of the system they would like to use.

This was met with confusion. One of the field staff said that he felt like his time was being wasted and suggested they rather discuss the functionality of the system and leave the design up to the researcher. This response may have been affected by the fact that the workshop was at the end of an order day, just after the busiest and most stressful time of the week. The rest of the workshop was then spent discussing functionality with two of the field staff dominating the discussion while other field staff members contributed very little. The researcher was careful during the workshop to avoid giving design ideas based on the early prototypes mentioned in the previous chapter.

The discussion generally agreed with the findings of the first iteration but additional requirements were discovered. There was an emphasis on searchable lists or hierarchical menus rather than scrolling through an alphabetical list of items. This was in contrast to what the TTO management had suggested, namely, that the field staff would require a scrollable list. This demonstrates that the field staff were taking advantage of the capabilities of digital systems rather than simply moving the paper forms onto a digital medium as is. The general idea conveyed was that the system needs to be simple and quick to use. Figure 7 shows some of the ideas given during the PD workshop:

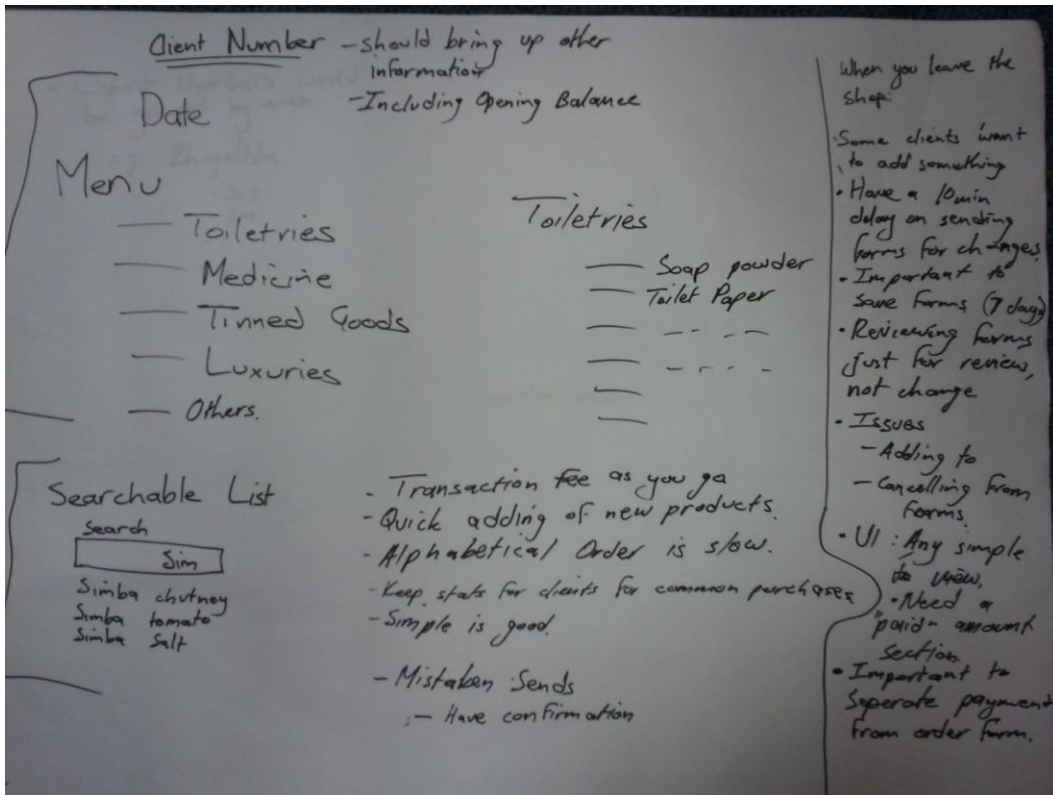


Figure 7 – Feedback from the PD Workshop

Although there was no collaboration with the field staff on the actual interface design, the discussion revealed their priorities and some ideas around the use of the system. This provided the direction required to continue prototyping and developing the user interface. With an understanding of the desires of the users, and the requirements of the system, the back-end could be implemented as well.

5.2. Back-end Implementation

In order to design the back-end of the system, the requirements gained through the CI must be considered. The following requirements have been extracted from the CI in the previous chapter and the PD workshop discussed earlier in this chapter. They are presented in a summary table (Table 2) and have been grouped to highlight areas of design that require consideration.

Table 2 - Summary of Requirements

Information Communication	Orders need to be sent to the TTO office so that they arrive before the field staff do, allowing more time for data capturing
	Field Staff need access to information remotely, specifically: <ul style="list-style-type: none"> • Spazas' opening and closing account balances • Spazas' details, such as name and contact number • Order totals (requires information communication because of the transaction fee)
	The stock and price list information must be updated remotely from time to time

Ongoing Maintenance Requirements	The costs incurred using the new system should be less than the costs incurred using their previous system
	The stock and prices must be easily updatable by the administration staff at the TTO office
Information Presentation	The orders received should be easily accessible to the administration staff
Other Requirements	Amounts of cash received by the field staff should be recorded with the order
	The system should be a mobile-based system using Android handsets
	Other minor details gained from the CI should be considered, such as only needing a spaza's client number to determine all other spaza-related information

The information communication requirements all require data to be sent between the TTO office and the field staff. The ongoing maintenance and information presentation requirements generally involve interaction between the administration staff and the information used by the system. When the requirements are viewed from an information-requirements perspective, we get the following requirements, as seen in Table 3:

Table 3 - Information Requirements

Information Communication (only simple requests and responses)	The mobile application requests information from TTO. This request is followed by a response with the information
	The mobile application can submit a completed order form, after which an acknowledgement is expected to confirm the submission
Interaction of Administration Staff with the Server Information	Spaza information must be updated as required, including weekly account balance updates
	The order transaction fees must be easily updatable as they change with inflation
	The stock list and associated prices should be easily updatable as required
	Invoice numbers should be automatically generated by the application running at TTO
	A familiar interface should be used to facilitate data manipulation for the administration staff: <ul style="list-style-type: none"> • This allows for one less new thing to learn for the administration staff and provides some familiarity • This also applies when administration staff view received orders. • Microsoft Excel is a suitable program for this task as the administration staff are already familiar with it.

In order to consider how these requirements may fit an existing design model suited to information management and communication, it is helpful to abstract the requirements. A table of abstract requirements follows in Table 4:

Table 4 - Abstract Requirements

A Mobile Application Making Simple Requests	The mobile application need only send a request and receive a response. The requests include data requests or form submissions.
An Application to Handle Mobile Requests	This application requires data from TTO to serve the mobile requests
	It also requires the ability to output submitted order forms and make them accessible to TTO administration staff
Easily Available Data for Administration Staff	The information presented to the request handling application must be easily editable
	The order forms output by the server must be easily readable

Figure 8 links these actions and models the interactions:

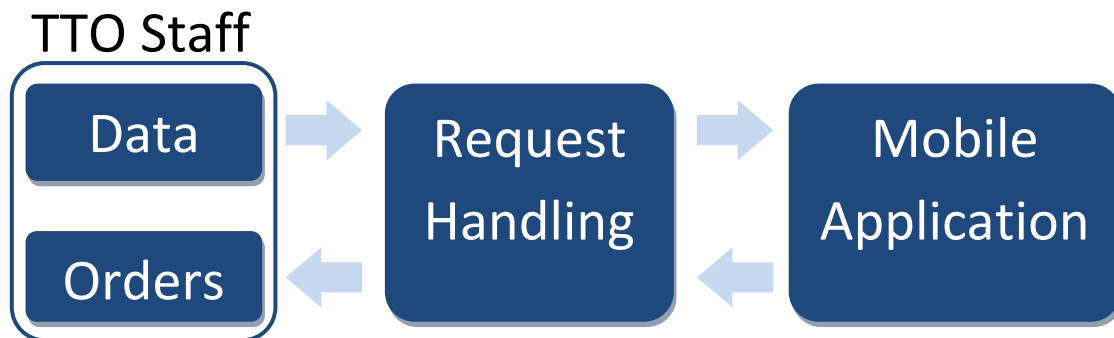


Figure 8 – System Interaction Model

The client-server software model fits well with this abstract model if we consider the mobile application to be the client, and the request-handling application to be the server. The mobile client then sends requests to the server. These requests are handled using data that is managed by the TTO administration staff, and appropriate responses sent back to the client. Figure 9 describes this software model:

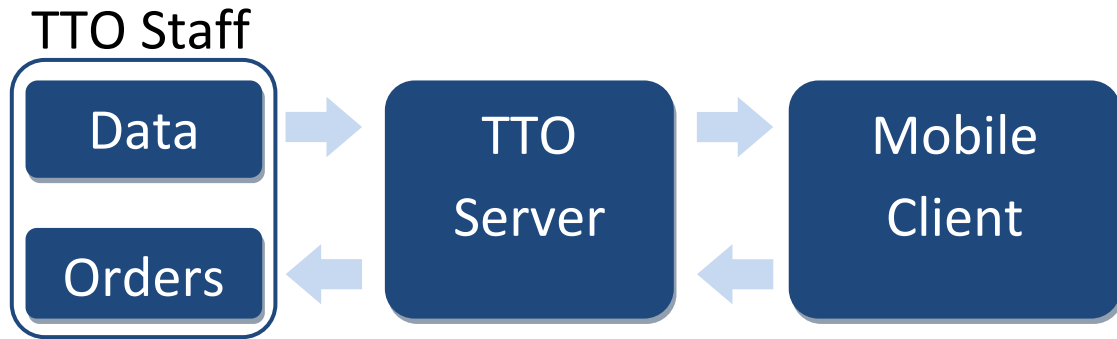


Figure 9 – Client-Server Model

Thus, a client-server software model was used.

The only significant costs incurred in communication between the client and the server are the mobile data costs. The largest data requirement occurs when updating the order form. This uses approximately 6KB of data with the current TTO order form which, at a rate of R2 per MB (Vodacom MyMeg, 2011), costs 1.2c. This is negligible compared to the cost of the field staff driving up to 100 kilometers per order day.

Since all of the communication between the server and the mobile client is done via a single request from the mobile client to the server followed by a single response, Hypertext Transfer Protocol (HTTP) is an ideal communication protocol to use. Because of this, a Python Common Gateway Interface (CGI) server was used to handle the HTTP requests. The built-in Python CGI server implementation was used with Python scripts to handle the response generation. The discussion around the choice of mobile platform can be read in section 4.1.7.

When testing the server's responses to HTTP requests, an internet browser was used because it provides an easy way to generate and send HTTP requests with a human-readable parameter list. The requests can be built using the browser's address bar with parameters being set using the "?" symbol. For example, in the following request

```
http://localhost:8000/cgi-bin/server_script.py?browser_test=1
```

the "browser_test" parameter is set to "1". Other parameters can be set in a similar manner. During testing, the responses from the server were wrapped in Hypertext Markup Language (HTML) so that they could be viewed in the browser.

The accounting software used by TTO is proprietary, making it difficult to integrate with. This meant that some intermediate data step was required. Since the TTO administration staff were already familiar with Microsoft Excel, Comma-Separated Value (CSV) files were used. CSV files are human-readable, easily modifiable using Microsoft Excel, and easy to manipulate programmatically due to their lack of formatting.

This provided a platform on which to begin adding functionality to the mobile application prototype.

5.3. User-Interface Redesign

The initial prototypes were used to explore the feasible capabilities of Android and to help the designer consider and frame the design challenges in Reflective Practice. These prototypes now doubled as a code base from which to work. The initial prototypes centered largely on a scrollable list for ordering, but this was slow and cumbersome. The design also required the user to enter all of the spaza information with each order. This allowed for erroneous data to be input that would conflict with the details on the TTO records.

The PD workshop showed that only the spaza's client number need be recorded, and that either hierarchical menus or searchable lists should be employed rather than one long, scrollable list.

The ordering mechanism was then changed to reflect this and use a searchable drop-down list. The details page was also updated to only allow the spaza's client number to be edited. The summary page was then developed to review the order and account information.

Figure 10 and Figure 11 show the Details tab, and Figure 12 and Figure 13 show the Order tab before and after these changes were made:

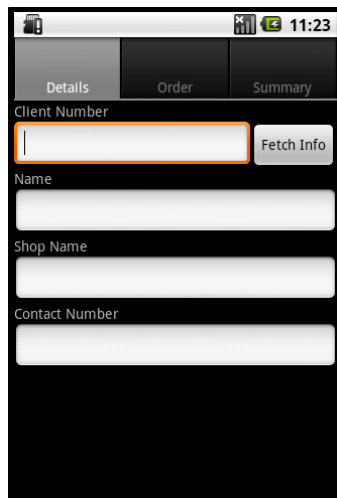


Figure 10 – Details (before)

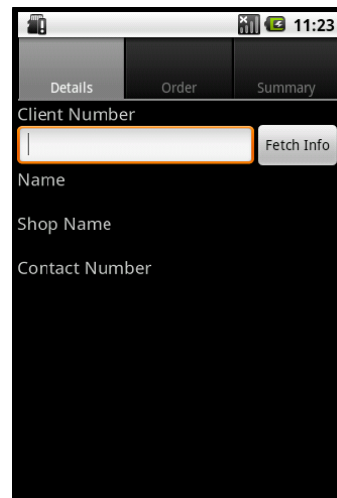


Figure 11 – Details (after)



Figure 12 – Order (before)

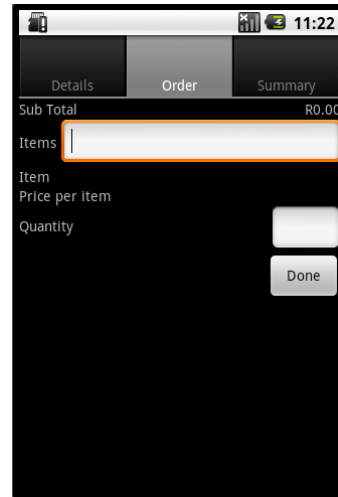


Figure 13 – Order (after)

The field staff had been involved in a PD workshop and had engaged, to some extent, with the idea of a new system. They had not seen any prototypes up to this point though. The PD workshop had provided input from the field staff, mostly in terms of functionality rather than user interface design. Any further attempts to gain input from the field staff at this stage would likely result in frustration for them because they had not yet seen the results of their initial input. It would now be important to show the field staff a hi-fidelity prototype with some features implemented so that the next design iteration could begin.

6. Iteration Three

Having refined the initial prototypes to fit the priorities and desires that the users expressed during the PD workshop, it was important to check if the user interface matched the desires of the users. It was also important to evaluate the user interface heuristically for design flaws that would not be immediately apparent to the users. Further user interface refinement would be required based on the feedback gained during this iteration.

6.1. Conceptual Model Extraction

An appropriate method of determining how well a system matches a user's idea of a system is a CME, as described in section 3.3.2. To get the most feedback out of a CME, one would ideally run it with individual users. This was not possible with the field staff, however, due to time constraints, so a CME was arranged as a group meeting at the end of an order day. There were not enough handsets available for each of the five field staff users, so hands-on use of the system was not possible. Instead, a PowerPoint slideshow was prepared showing screenshots of the system in various configurations (see Appendix C) with a number of questions prepared for each slide (see Appendix D). The questions were purposefully phrased to avoid hinting at usage methods. These questions focused largely on asking the field staff how they would go about performing a task, given the slide they were presented with. The tasks in question were mostly tasks performed regularly using the paper order sheets, such as adding items to an order, and checking a price.

The CME began with an explanation to the field staff about the purpose of the CME and the types of questions they would be asked. After needing some coaxing for the first two questions, the field staff began to respond to the questions easily. Each of the field staff contributed during the CME. The responsiveness was in strong contrast with the unwillingness to participate in the PD workshop.

A new field staff member who had not been part of the process until then stated that he would prefer to just be trained to use the system rather than being a part of the CME. One of the field staff who had been involved in the CI suggested that they all participate, after which the CME proceeded. It was valuable having that relationship with some of the field staff from the CI because they encouraged the other field staff to participate. In a sense, they were the Human Access Point (HAP) (Marsden et al., 2008) of the NGO, and promoted the project internally.

When the field staff were shown the slides and asked the corresponding questions, most of their answers of how they would perform a task matched the design of the system. There were six user interface elements that were confusing to them though: four related to badly labeled buttons or text fields, one related to expected functionality that was not present, and the last was an unexpected input type. Figure 14 shows the interface that the field staff saw, followed by Table 5 which summarizes the feedback:

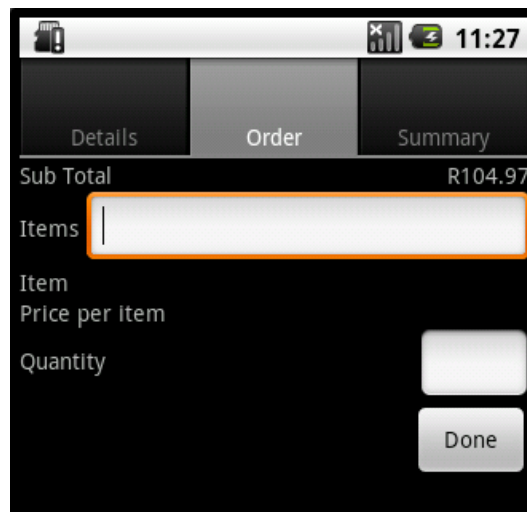


Figure 14 – CME Interface (Order)

Table 5 - CME Results Summary

	Field Staff Conceptual Model	Model of the System
1	When ordering an item, the expectation was to enter a number into the quantity field and move on.	Having entered a value into the quantity field, one must click the “Done” button to add the current item to the order
2	The expectation of the “Price per item” field was to give: unit price * unit quantity	The “Price per item” field was intended to be the unit price
3	The “Done” button was perceived to complete	The “Done” button was intended to be used to

	the order	add items to the order
4	From this page, the “Summary” tab was viewed as a page where one could edit or cancel items on the order	The “Summary” tab was intended to just provide an overview of the order with account information

Figure 15 shows two options for input types for the client number:

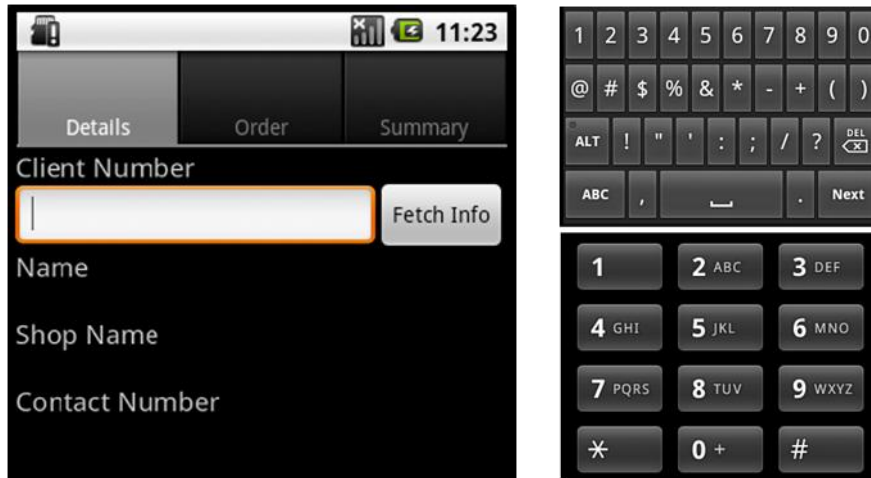


Figure 15 – CME Interface (Details)

	Field Staff Conceptual Model	Model of the System
5	It was expected that a phone-number-type keyboard (right-bottom) would become available to enter the client number	Android’s numeric keyboard (right-top) became available, which includes punctuation keys and smaller numeric buttons

Figure 16 shows the summary page of the application:

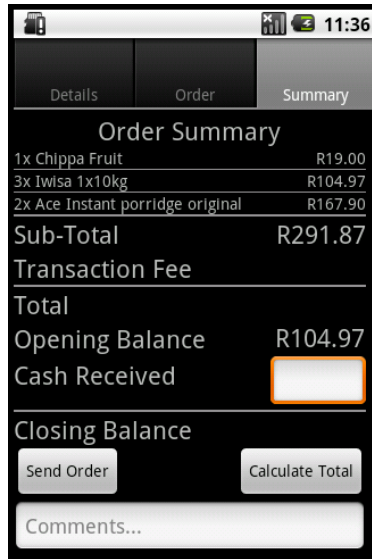


Figure 16 – CME Interface (Summary)

Field Staff Conceptual Model	Model of the System
6 It was expected that the “Transaction Fee” would be calculated as each item was added to the order	The “Transaction Fee” was only calculated after clicking “Calculate Total”

These conceptual mismatches would need to be addressed to improve the design and usability of the system.

6.2. Heuristic Evaluation

Apart from the CME evaluation, a heuristic evaluation of the system was performed by a usability expert. In terms of a cost-to-benefit ratio, it is optimal to use between three and five usability experts to evaluate a system (Nielsen and Molich, 1990). Having seen a hi-fidelity prototype of the system, TTO was keen to get the system into use and was trying to hurry the process. This time pressure made it difficult to conduct the heuristic evaluation with more than one expert. This was not ideal, but a thin heuristic evaluation would still contribute positively to the design of the system.

The evaluation concluded that the user feedback was poor and would need to be improved. Specifically, when users performed actions that required communication with the server, there would be no feedback during the period while waiting for the server response. The application would appear to do nothing.

Better feedback had initially been put in and then removed prior to the heuristic evaluation because communication delay with the server had been negligible during testing on the emulator. When moving to the mobile device, this delay increased substantially.

Better feedback for the users would need to be reintroduced along with the changes arising from the CME.

6.3. Interface Refinement

The design problems discovered during the CME and the heuristic evaluation were addressed and the updates implemented. The following figures illustrate the updates as a result of the CME. Figure 17 shows the updates to the Order tab and Table 6 describes the changes:

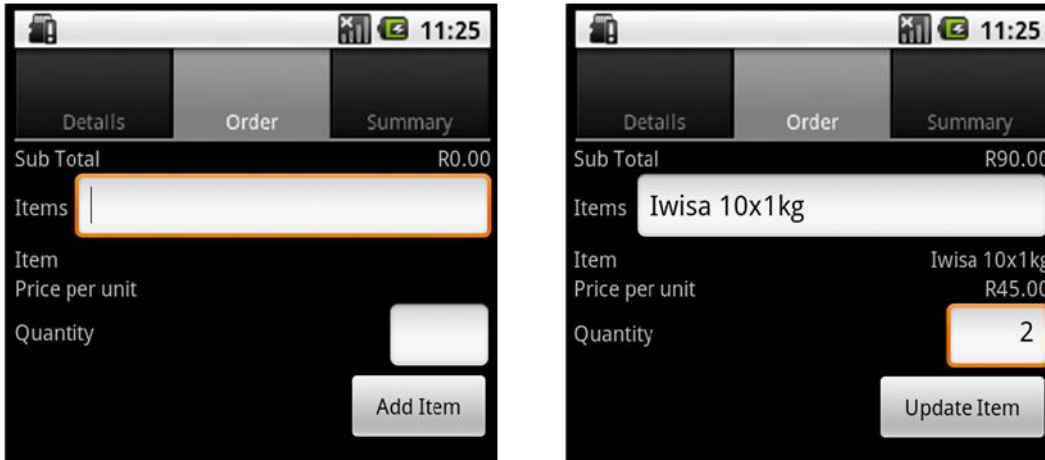


Figure 17 – Updated Order Page

Table 6 - Modifications after the CME

Problem Number	Modification
1, 3 and 4	The “Done” button was changed to “Add Item” if an item was not already on the order list, or “Update Item” if the item was on the list.
2	The “Price per item” label was changed to “Price per unit”

Problem number five was addressed by changing the input type to the phone-number keypad (the bottom keypad in Figure 15). Problem number six was not addressed immediately but listed as future work.

The following figures illustrate the updates as a result of the heuristic evaluation:

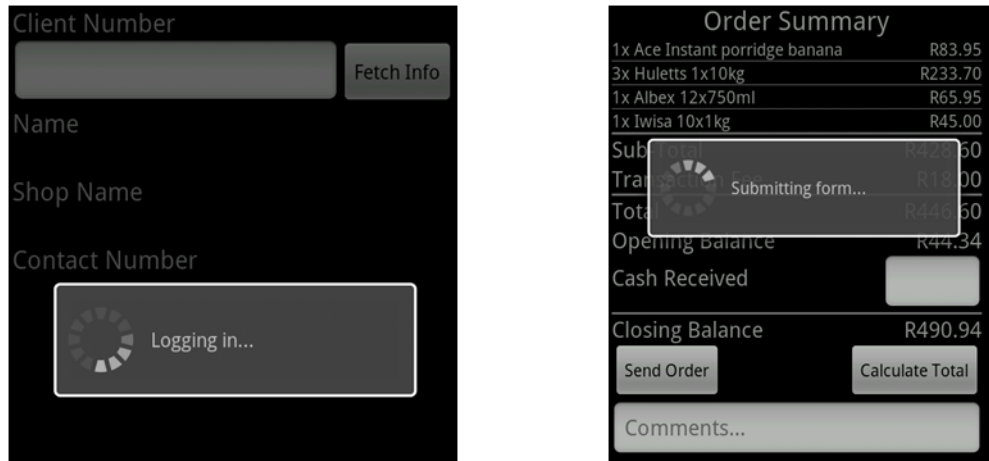


Figure 18 – Feedback to the Users (Blocking)

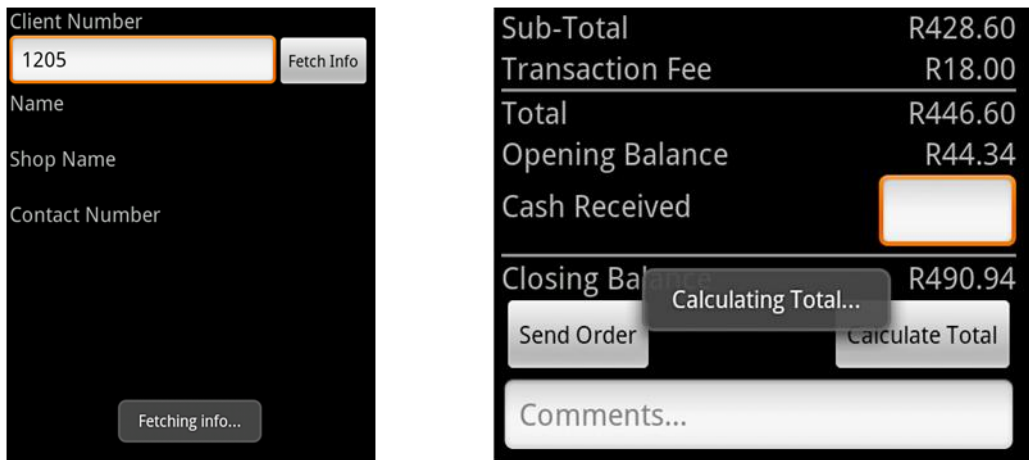


Figure 19 – Feedback to the Users (Non-Blocking)

Figure 18 shows blocking dialog boxes that signal to the user that a process is running which stops the users from continuing to use the system. Figure 19 shows non-blocking dialog boxes where the user can continue using the system while information is fetched from the server. These dialogues make the state of the system more clear to the user by informing them of actions that would otherwise not yet be visible.

Although the number of changes required was relatively small, these changes were important in improving the usability and decreasing the effort required to learn how to use the system.

Having made these changes, the system was ready to be tested in the field.

7. Iteration Four

Once the model of the implemented system closely matched the field staff's conceptual model of the system, the field staff could be easily trained. A training session was conducted with the field staff, which was augmented by giving the field staff and administration staff user manuals related to their tasks. This was followed by a short pilot study to test the system in the field. The pilot study also revealed some design flaws that had gone unnoticed.

7.1. User Manuals

To support long-term use and usability of the system as well as assisting in training, user manuals were developed for the field staff and for the administration staff. This would also serve as a resource for referencing and future training.

Pictures were used where appropriate to demonstrate descriptions given in the text of the manual. Tasks were described step-by-step in an attempt to be clear and descriptions were also kept concise to be more helpful and accessible (Abrams et al., 2004), rather than expecting users to read through more text than necessary.

Table 7 provides a summary of the content of the user manuals for the administration staff and the field staff.

Table 7 - Summary of the User Manuals' Contents

Administration Staff Manual	A description of how to save correctly-formatted files
	A description of how and when to maintain these files
	Instructions for running the server if it was closed
	An outline of common error messages on the mobile client and what to do to remedy them
Field Staff Manual	Step-by-step instructions on how to perform common tasks
	Tips and a "how-to" section for using the Android touch-screen interface

The administration staff's user manual can be seen in Appendix E and the field staff's user manual can be seen in Appendix F.

These training manuals were given to the administration and field staff after the training session. This would enable them to check how to perform tasks if they forget.

7.2. Training Session

The training session served as an introduction to the system for the five field staff who could potentially use the system. The intention was to demonstrate typical usage of the system while placing an order. This was to help the field staff to feel comfortable as they begin using the system in the field.

The training consisted of two parts: a group training presentation, and a hands-on training time using the actual mobile devices. It was planned at the end of an order day because all of the field staff would be at the office.

The first part of the training session was run as a group with all the field staff. This was to encourage a sense of group participation in using the system and to encourage group learning. Gitau et al. (Gitau et al., 2009) noted how users helped each other when faced with confusion in using a system. They found it easier to get help from peers than from the researcher.

The use-cases used in demonstrating the system during training were the same use-cases as were used for the CME. This was done to add a sense of familiarity for the field staff since they would have thought about similar images before. Instead of the CME questions accompanying the presentation, descriptions of how to use the system followed each slide.

The intention was to do a live demonstration using a projector and the Android device emulator so that all of the field staff could see. This was cut short however, due to a lack of internet connectivity which didn't allow for client-server communication. A brief explanation of each of the three interface pages was given but no functionality was demonstrated.

The purpose of the second part of the training was to let the field staff work through the different stages involved in ordering stock using the mobile handsets. This would provide some initial practical experience in placing orders using the digital system. Due to the small number of handsets available and to time constraints, this part of the training could not be run with each trainee using a handset on their own. The best that could be managed in the time available was to run it with pairs of field staff using a mobile handset. Each pair of staff was asked to record an order using the mobile handsets while the researcher watched and helped when the staff needed it. There was some difficulty using the touch-screen interface, but the processes were mostly understood.

At the end of the training, the field staff were asked if they were confused about anything or had any questions. This was simply to close off the training for the day. One of the field staff made a suggestion that exposed an earlier assumption that the application would be closed while driving between each order. This would impact how form data is reset after a submission, and would need to be addressed in the next implementation phase.

Due to an unexpected lack of internet access and time pressure, the training session did not go according to plan, and the field staff expressed to the TTO management that they were not comfortable using the system yet.

A follow-up training session was planned at a less time-pressured period, rather than at the end of an order day. Due to an illness with the liaison at TTO, this meeting was not organized. The two field staff who had been designated to use the system first, happened to be at TTO though, so a one-on-one walkthrough of the order process was conducted with them. They seemed much more confident than after the first training session and both of them successfully placed orders.

Although neither training session proceeded as planned, the goal of teaching the field staff how to place orders using the mobile client had been achieved. Since they were able to successfully place orders, it was time to test the system in the field during a short pilot study.

7.3. Pilot Study

A pilot study was conducted as an evaluation tool with two field staff and an administration staff member on day one and one field staff member on day two. This would provide an opportunity to test the system in the field under regular conditions and would give the field staff and administration staff some practical experience. The pilot study was planned in two parts over two days: one day at the TTO office and the second day with the field staff in the field.

For the first day, the field staff were taking phone orders from the TTO office and recording the orders using the mobile client. This allowed the designer to monitor from the same room both the client and server sides of the process in case of problems with either part.

After approximately 30 minutes of struggling with the touch-screen interface, the field staff started becoming familiar with it. The stock-ordering proceeded smoothly with orders successfully arriving on the TTO server and the administration staff being able to begin data-capturing a full four hours earlier than usual. This generated excitement in the office as the staff saw the system working.

The first day exposed inconsistencies between the price list available to the server and that of the accounting package. The price list was updated accordingly to address this.

The purpose of the second day of the pilot study was to focus on the field staff's ability to use the application in an acceptable manner and to take note of the interactions between the field staff and the spaza. This ran much like the CI where the researcher accompanied the field staff during a normal order day, except this time taking orders using the mobile client.

Almost immediately, the field staff member said that he could not read the handset's screen because he had forgotten to bring his reading glasses. This was not a problem for him when taking orders using the paper forms. For the remainder of the day, the researcher operated the handset while the field staff member interacted with the spaza owners. Although this would not provide the field staff member with much experience, it would serve to test the system in the field.

Apart from the human error, two problems with the system were discovered that had gone unnoticed until now. The first was a serious display bug that resulted in stock items being hidden.



Figure 20 – Display Bug (a)

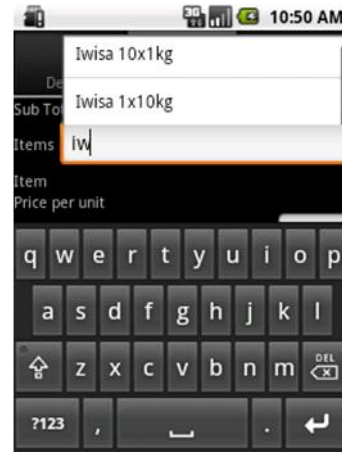


Figure 21 – Display Bug (b)

In Figure 20, it is clear that there are more items than just the item shown, however when the user scrolls over the list in Figure 21, only two items are displayed while two other items are hidden. When testing on the Android device emulator, the scroll list would drop down rather than up, showing all the items correctly. Due to the small screen of the devices used by the field staff, the scroll list would drop up, allowing insufficient space to render correctly. This would need to be addressed in the next implementation phase.

The second error was a file-formatting error on the server. Negative balances had been stored using parentheses rather than a minus sign (“(115.10)” rather than “-115.10”), and commas had been introduced to delimit three-digit groups (“1,215.00” rather than “1215.00”).

These problems resulted in slow ordering while the office was contacted to address the problems. This created frustration and embarrassment for the field staff member when interacting with the spazas. The orders that were unaffected by these bugs were submitted successfully though.

The pilot had served its evaluation purpose by exposing problems that had not yet been discovered and by demonstrating that orders can be delivered successfully using a mobile phone from the field. The interactions between the field staff and the spazas had gone largely unchanged, apart from the embarrassment and frustration associated with the bugs. The problems discovered would now need to be addressed.

7.4. Interface and Process Refinement

The display bug and the file formatting problems discovered during the pilot study and the suggestion made at the end of the training session were now implemented.

The display bug was fixed by making the top tabs narrower, causing the drop-down list to actually drop down. This obscured the keypad, but only when the scroll list was in focus, meaning the keypad was not likely to be in use. Figure 22 shows the interface when the scroll list is not in focus, and Figure 23 shows the scroll list in focus, correctly displaying all of the items:

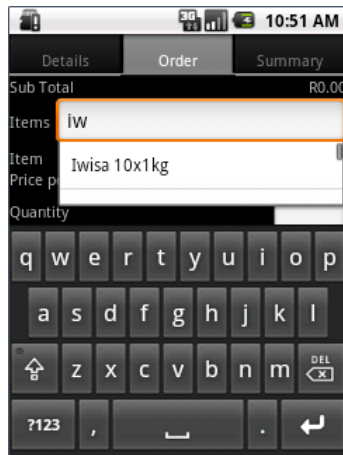


Figure 22 – Item List not in Focus

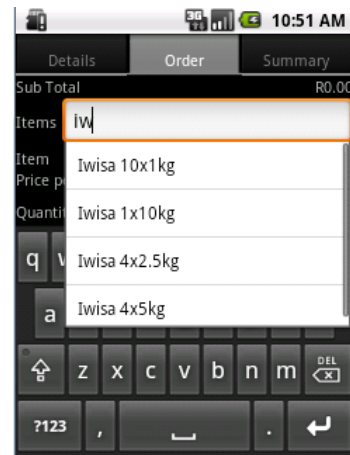


Figure 23 – Item List in Focus

The administration staff were informed of the correct number formats for balances. The user manuals were updated accordingly to be more specific.

The client was modified so that form data was cleared after each order was submitted, rather than when the client application was closed. The assumption had been that the field staff would close the application while driving between spazas but this was not the case.

The field staff had been trained how to use the system and were now able to submit orders using the mobile handset. The pilot study had served its purpose as an evaluation tool and helped to uncover a number of problems as well as demonstrating that orders could be successfully sent to the TTO server via the mobile handset. The problems discovered during the pilot and training sessions had been addressed. The system was now ready to begin regular use in a longitudinal study.

8. Iteration Five and Ongoing Use

Following the pilot study, TTO continued to use the system intermittently while the researcher monitored whether any new problems were being discovered. After a period of use, evaluation meetings were planned to get feedback from the field staff to determine how the system could be improved.

8.1. Intermittent Usage

The intermittent use of the system following the pilot study was caused by two factors. There were a number of human errors that provided barriers to usage, such as forgetting to charge the handsets before use, to bring reading glasses and to bring pencils to use as a stylus. The field staff were also facing problems with HTTP requests timing out and the application failing to connect to the server. These factors reduced the usage of the system. On the other side, there was pressure on the field staff from the TTO management to use the system more. The management had now seen the benefits of the system during the pilot study and wanted to begin taking advantage of it. Blame was laid on the field staff for the human errors and some technical errors. This created tension at the TTO office.

To help overcome some of these barriers and encourage use of the system, the researcher offered to be present during orders. Having help present during orders may provide the field staff with the confidence to use the system, knowing that problems could be addressed immediately.

This offer was turned down by TTO however. They stated that they would prefer to deal with the problems on their own and learn to use the system. This demonstrated a strong sense of ownership, internalization and independence from the researcher. The step towards independence was also an important step towards sustainability and long-term use.

This was followed by almost two months of significantly reduced communication between the researcher and TTO. Despite attempts made by the researcher to keep channels open between himself and TTO, they were unresponsive to further communication during this period. After a number of attempts were made, the researcher suspended these attempts to allow TTO to pursue the course of action they desired. As a result, the transition from the pilot study into regular use was somewhat obscured for the researcher.

8.2. Evaluation and Modification

Evaluation was required to determine if further problems had been discovered during ongoing use and if any improvements could be made. The evaluation also needed to determine to what extent TTO was using the system. To this end, weekly evaluation meetings were planned with the two field staff who had been using the system.

The meetings were run as short, semi-structured interviews, where the field staff were asked if they had encountered any problems that week and if they could think of any improvements to the system. Semi-structured interviews allowed the feedback to be more conversational and allowed the researcher to probe further into ideas and problems.

These meetings took place alongside continued use of the system for three consecutive weeks. For the fourth week, TTO stated that there was nothing new to report and declined the meeting. This marked the end of these evaluation meetings.

During the two months of reduced communication, the intermittent use of the system had grown into weekly use with the field staff confidently using the system.

The feedback from these meetings was predominantly positive but some problems were described and some ideas for additional functionality were expressed. The problems could be addressed immediately but the additional functionality could not be implemented due to the time constraints of the project. A summary of the problems that were addressed appears in

	Problem Described	Modification
1	Item variations such as “Sunlight 10x250g” and “Sunlight 10x250g pink” are not present	These items were added to the order list
2	The field staff were experiencing many HTTP request timeouts	The timeout time was increased to reduce the number of timeouts

3	Feedback on the client for missing account balances on the server was uninformative	The feedback was improved to be more descriptive
4	The client would crash under certain circumstances	This bug was fixed
5	Under certain circumstances, incomplete forms could be submitted	The form logic was improved to stop this
6	The server was being closed each night, stopping form submission until the administration staff arrived at TTO	TTO's IT managers were consulted and the problem was resolved

below:

Table 8 - Summary of Problems During Ongoing Use

	Problem Described	Modification
1	Item variations such as "Sunlight 10x250g" and "Sunlight 10x250g pink" are not present	These items were added to the order list
2	The field staff were experiencing many HTTP request timeouts	The timeout time was increased to reduce the number of timeouts
3	Feedback on the client for missing account balances on the server was uninformative	The feedback was improved to be more descriptive
4	The client would crash under certain circumstances	This bug was fixed
5	Under certain circumstances, incomplete forms could be submitted	The form logic was improved to stop this
6	The server was being closed each night, stopping form submission until the administration staff arrived at TTO	TTO's IT managers were consulted and the problem was resolved

All of these problems are related to the digital ordering system, except problem number one. These item variations did not appear on the printed order sheet either, but were written in by the field staff next to the appropriate field. To account for these item variations, the field staff had been entering the description into the "Comments" field of the form but this was time consuming.

The ideas for additional functionality are presented in Table 9 below:

Table 9 - Summary of Additional Functionality Ideas

	Idea
1	To add stock availability information to the order list
2	To allow orders to be cached on the mobile device before being sent
3	To allow previous orders to be retrieved on the phone when discussing account balances with spazas

In reference to the first idea, at the time of writing, the administration staff would send out an SMS to the field staff notifying them of what stock was unavailable for that order day. It would be a valuable addition for this information to be delivered via the digital ordering system.

8.3. Towards Sustainability

Up until this point, any modifications to the mobile client required the mobile handsets to be brought back to the TTO office, linked to the researcher's laptop computer and the new client installed. This would also be the case if additional mobile handsets were purchased, and was therefore an unsustainable model.

To address this, a system was put in place to allow TTO to update and install the client software remotely, without the assistance of the researcher. This would allow for sustainability and autonomy. One of the simplest ways of installing software on an Android device is to download the application using the Android internet browser, and then follow the prompt to install the application. Dropbox (Dropbox, 2011), a file sharing platform, was used to host the client application to allow for mobile downloads.

The updated client, as a result of the modifications done in section 8.2, was then installed by the field staff on their mobile handsets. This was followed by continued use of the system and another period of reduced communication between TTO and the researcher for approximately one month.

Although intermittent use of the system followed the pilot study, TTO worked through a number of operational problems, and did so without the help of the researcher. This led to consistent use. A number of problems discovered during sustained use were addressed. Once these had been addressed, use of the system continued without mention of ongoing problems, even though the researcher prompted the field staff a number of times for any problems they were facing.

The evaluations up to this point have been concerned with evaluating progressive designs as they converge to an appropriate system for TTO. This has been part of the iterative development model. Now that the system was being consistently used without ongoing problems reported, it was time to evaluate the project as a whole in terms of the research questions.

9. Evaluation

Many HCI evaluations focus on quantitative measurements of usability such as the time taken to complete a task and the number of errors incurred while doing so. In many contexts, these evaluations are appropriate, but in some contexts they are inappropriate because the goal of the research is different. Greenberg and Buxton (Greenberg and Buxton, 2008) state that "the choice of evaluation methodology – if any – must arise from and be appropriate for the actual problem or research question under consideration."

In this context, the time taken and errors incurred in interacting with the system make a negligible impact on the effectiveness of the system. The time taken to record and submit an order is small compared to the time spent driving between spazas. In an earlier interview, one of the field staff stated "If it wasn't for travelling, one could finish the day within an hour." Therefore, time taken to record and submit an order is not an appropriate measurement.

Similarly, the number of user errors incurred while placing orders also has a negligible effect on the overall effectiveness of the system, provided the actual orders are correct and the error count is below a reasonable threshold. As seen in the previous chapters, usability problems were addressed in each iteration until TTO had nothing new to report. This would suggest that the number of errors incurred while using the system is at an acceptable level for them. Thus, no quantitative measure of errors is necessary.

If an evaluation of time and errors is inappropriate, another more appropriate approach should be considered.

9.1. Determining an Appropriate Evaluation Approach

In light of Greenberg and Buxton, to determine an appropriate approach to evaluation, we should consider the actual problem and the research questions of the project. This requires a review of the research questions, as described in section 1.4:

Research Question One: Can we migrate TTO’s process and personnel from a paper-based approach to one using digital technology? – can we work with TTO to gain an understanding of their practice sufficiently well that we can, with them, design and implement an alternative to their existing system

Research Question Two: If we can indeed implement the system, will it improve the running of the NGO? – Gitau and Marsden (Gitau and Marsden, 2009) make the argument that in ICT4D projects with an NGO partner, we should adopt the success criteria of the NGO. Therefore we will determine how the NGO measures its own success and use those criteria to evaluate our project

An evaluation approach for Research Question One will be discussed in the following section. Thereafter, Research Question Two will be evaluated through a reflective discussion.

9.1.1. Discussion: Research Question One

When evaluating whether the NGO has been positively and effectively impacted, it is important to use evaluation criteria set by the NGO (Gitau and Marsden, 2009). This is so that the measurement is in the NGO’s terms, rather than the researcher dictating whether or not an intervention has been a success.

TTO did not give an explicit list of objectives framed as success criteria however. The only explicit goal the management mentioned was increased efficiency. The problems with the ordering system (see section 4.1.4), if addressed, were suggested as a list of benefits. These provide an implicit list of success criteria. There are also unspoken assumptions about the success of the project such as the system actually supporting stock-ordering.

If the problems mentioned in section 4.1.4 are phrased as success criteria, TTO’s list of success criteria as seen below in Table 10, in no particular order, is:

Table 10 - Success Criteria

To have increased efficiency
To reduce the amount of driving that the field staff are required to do

To improve the flexibility of the order sheet in terms of updating items and prices
To increase the field staff's access to information, in particular: <ul style="list-style-type: none"> • Order Totals • Spazas' Account Balances • Transaction Fees
To reduce the workload spikes for administration staff
To improve the recording of cash received from spazas
To reduce the costs associated with phone orders

TTO's desire for "increased efficiency" is vague though. They do not make it clear what they mean, but in the context in which it was said, it appears they were referring to the field staff and the stock ordering system. As described earlier in the chapter, the bound on the efficiency of the field staff is in the time taken while driving between spazas and not the stock ordering process. TTO's desire was that the field staff continue driving to the spazas to take orders so by choice, the field staff's efficiency in a broader sense was not going to change.

This suggests that TTO did not know exactly what they wanted by "increased efficiency". It is tempting at this point to suggest a definition of efficiency in TTO's context and how one might measure it, but this would not be in the NGO's own terms. Instead, TTO may still be able to assess whether they have an increased sense of efficiency, even if it is not well-defined.

9.2. Evaluation Method

Having identified a list of success criteria, the evaluation method must be considered. Since the evaluation should be done with the NGO, one way of doing this is by interviewing staff at TTO to determine if the expected benefits of the system have been realized and if they perceive the system to have been a success. Semi-structured face-to-face interviews have been shown to be effective in evaluations with NGOs (Donner et al., 2011). They allow the researcher to follow on from and probe remarks made by the interviewees where structured interviews or questionnaires would not allow.

Different groups of staff at TTO would need to be interviewed to assess the range of success criteria. The field staff and administration staff would need to be interviewed to evaluate aspects relating to their work. The management would need to be interviewed to determine if there has been a sense of increased efficiency at an organizational level. Table 11 describes which staff will be interviewed to assess which criteria:

Table 11 - Table of Success Criteria Interviews

Field Staff	Whether the amount of driving has changed
	Whether there has been increased access to information in terms of: <ul style="list-style-type: none"> • Order Totals • Spazas' Account Balances • Transaction Fees
	Also contributions in terms of : <ul style="list-style-type: none"> • Whether order form flexibility has increased

	<ul style="list-style-type: none"> • Whether workload spikes for the administration staff have been reduced • Whether record keeping of cash received has improved
Administration Staff	Whether order form flexibility has increased
	Whether workload spikes have been reduced
	Whether record keeping of cash received has improved
	Whether the cost of phone orders has been reduced
Management	Whether there has been a sense of increased efficiency
	Whether the amount of field staff driving has changed, according to records
	Whether the management considers the project, as a whole, to have been a success

Although it is important to evaluate each of the success criteria individually, it is also important to ask the management whether or not they consider the project, as a whole, a success.

In these evaluation meetings, two field staff, one administration staff member and two of the management staff were interviewed.

9.3. Interviews with TTO Staff

The evaluation interviews were arranged with each of the groups of TTO staff. Questions were prepared to guide the conversation of the interview towards addressing each of the success criteria. Each of the interviews will be discussed separately in the following three sections.

9.3.1. Interview with the Field Staff

This interview was conducted with the two field staff who had been using the system. Each of the questions asked will now be discussed with some direct quotes from the field staff.

Question: Has your amount of driving changed since starting to use the system?

They answered in the negative, saying that it wouldn't have changed since they still need to go out to the spazas. This was the anticipated response.

Although this was initially one of the expected benefits, the decision from the management to have the field staff using the system meant that this benefit would not be realized.

Question: Has there been increased access to information, in particular, order totals, spaza account balances and transaction fees?

“Yes, because it’s readily available. It’s a useful tool” was the answer of one of the field staff. They found it especially helpful for large orders because they are totaled automatically rather than having to add items individually using a calculator and possibly making errors.

The number of mobile phone calls made to the TTO office to get this information was also reported to have been reduced to almost zero. This has lowered TTO’s running costs from a reduction of mobile phone calls. In time, this saving would effectively pay for new handsets if required.

Question: Are the [order-day] afternoons still so rushed for you and for the administration staff?

The short answer was that the afternoons are less busy. This was in part because the number of order days per week had been reduced to one and money collection now happened on non-order days. This reduced the workload associated with spaza account payments on order days. They did attribute some of the decrease in busyness to the fact that by 1:30pm most of the orders had already been submitted by phone and that there was less paperwork when they arrived. One of the field staff remarked that, “It has changed drastically, the shouting, stress and all that. It has gone down”.

A “drastic” reduction in shouting and stress will affect staff interactions positively and contribute to a more productive working environment. When considering, as a spectator, the changes to the staff caused by the introduction of the mobile system at TTO, this aspect stands out as being the most prominent.

The field staff were then asked about the success of the system as a whole, with a surprising answer.

Question: Do you feel like the system has been a success?

The following is the answer from one of the field staff, said in context, “I guess yes. There’s less paperwork. There’s less printing of order books. The success of it is that we can input into what we want in the whole system and how we want it [to] help us [rather] than if it was predesigned software. What is there is what we asked to be put [there] to facilitate quicker and easier ordering. The whole thing makes it easier because you didn’t have to take us through rigorous training. It’s quite a success”.

Firstly, the system is viewed as a success. It is interesting to note that he attributes the success of the system not to functionality provided by the system but to the PD approach used in development. Not requiring rigorous training is also mentioned as a positive, which supports the use of the CME in the design process. These are both positive comments towards a UCD approach and to PD in particular.

They are also interesting comments after the relative disinterest of the field staff during the PD workshop and the desire for a system to be developed by the designer followed by training on how to use it.

In some cultures, users’ feedback is sometimes skewed in an attempt to flatter the researcher or to avoid mentioning problems (Ho et al., 2009). Avoiding problems was not a trait of previous feedback from the field staff, so it is unlikely to have begun now. Starting the response with “I guess” and then positively addressing different aspects of the system suggests that the feedback was not premeditated but was considered while he spoke. Flattery therefore seems an unlikely motive.

All of the field staff’s responses were positive towards the success criteria, except the response for the amount of driving required. According to the field staff, the system is a success.

9.3.2. Interview with the Administration Staff

This interview was conducted with the administration staff with questions addressing the success criteria related to their work.

Question: Do you feel like there is more flexibility with the order forms than there used to be?

The answer was positive and accompanied by an anecdote about how she had changed the whole list of products and how quick it was to do.

After probing the response, it emerged that prices are only changed when the pricing catalogues are sent to the spazas. This is somewhat expected since spazas would need to be notified of price changes. Although TTO now has the potential to update their product and price list as often as they like, the limiting factor is the frequency of notifying the spazas of these changes.

A potential improvement suggested by the field staff would be to have stock availability built in. This can currently be done by simply removing unavailable items from the stock list. This flexibility is not being utilized though.

This did not seem as important an aspect to them as expected, but was a positive change nonetheless.

Question: Have the workload spikes in the afternoon improved?

She commented that she is not busy at all in the afternoons anymore even though her amount of work had increased slightly over the duration of the project. The improvement is that the workload is spread throughout the day now. She no longer has to rush capturing the orders or stay late on order days because the majority of the work has been done by the time the field staff return. As mentioned in the interview with the field staff, there had also been a reduction in shouting and stress – a clear benefit of the system.

Question: Has cash received by the field staff been better recorded while using the system?

The answer was in terms of saving time, in that the information arrived with the order, rather than with the field staff.

This question sought to address a problem mentioned earlier in the project where field staff were not keeping track of which spazas had paid which amounts. When it came to evaluating this aspect, both the administration staff and field staff responded as though it had never been a problem.

The field staff may have responded this way to defend their professionalism, but it was surprising that the administration staff would answer in this way given their involvement in the initial discussions about problems with the system.

Question: Are you saving money on phone orders?

“Oh yes definitely” was the answer. The field staff using the system are no longer phoned, saving up to 30 minutes of mobile calls per person per order day. At R2 per minute (Vodacom 4U, 2011), this is a saving of approximately R60 per order day.

Although the mobile handsets for this project were provided using research funds, these savings could be used to purchase new handsets, as described in the previous interview.

The administration staff were also asked whether they felt the project had been a success. This was more for supporting evidence since the management would be the main evaluators of the overall success of the project.

Question: Do you feel like the project, as a whole, has been a success?

Although she felt as though she hadn't realized the full benefits of the system yet, she felt that the benefits of the system were obvious, specifically the amount of time saved and the reduction of running costs.

The interview with the administration staff therefore pointed to the success of the system. The final interview was with the TTO management

9.3.3. Interview with the Management

All of those involved in the evaluation interview with the management had been involved in the initial CI. This interview addressed the overall success of the system.

Question: Do you feel like efficiency has increased because of the system?

The response was in the affirmative. When asked why, three points were given. These were referred to as "key elements" by the management and formed a clear list of success criteria that had not been conveyed with such clarity until now. They attributed the success of the system to the administration staff's ability to process orders throughout the day, to increased accuracy of orders recorded and to increased access to information. "Increased efficiency" had been an umbrella goal that had covered these three aspects.

A story was then told of how field staff sometimes had to drive from a spaza to the TTO office and back to get information like an account balance.

It is interesting that increased accuracy of mobile stock-ordering over paper stock-ordering was mentioned as a benefit of the system since it had not been an initial goal.

The clarity of the success criteria mentioned was surprising because prior to this interview, the only firm success criteria given by TTO had been increased efficiency. Throughout the project, the TTO management seemed to be developing and clarifying their priorities and goals. This was initially evident during the CI when looking at how their design priorities sharpened over time, and was now evident when considering evaluation criteria.

Had the researcher suggested a definition for "efficiency", it would certainly not have been in these terms. This would have resulted in an inappropriate evaluation. By allowing the NGO to evaluate criteria that seem ill-defined to the researcher, this problem is avoided.

Question: Has the amount of driving changed for the field staff using the system?

As expected, the answer was in the negative. This outcome was by design, even though it had been an initial goal.

Question: Do you consider the project as a whole to be a success?

“I do” was the response. A number of flaws were mentioned relating to TTO’s utilization of the system such as the initial reluctance to start using it, but the umbrella goal of “increased efficiency” was again employed to motivate the success of the system. Each of these three points was revisited with success attributed to each one, and the resulting conclusion that the overall project had been a success.

This highlights that the reason “increased efficiency” was the only success criteria TTO gave initially was because it was an umbrella term for other criteria. From the management’s point of view, asking about increased efficiency was the same as asking about the success of the system.

This concluded the evaluation interviews. A summary of the interview results follows.

9.3.4. Interview Summary

Each of the groups of staff at TTO felt that the project had been a success even though not all of the initial goals had been realized.

Table 12

Success Criteria	Evaluation
To have increased efficiency	A success when considering the three sub-points
To reduce the amount of driving that the field staff are required to do	Unsuccessful by choice of TTO
To improve the flexibility of the order sheet in terms of updating items and prices	A success although not utilized fully because of spaza notification constraints
To increase the field staff’s access to information, in particular: <ul style="list-style-type: none"> • Order Totals • Spazas’ Account Balances • Transaction Fees 	A success in all aspects
To reduce the workload spikes for administration staff	A success
To improve the recording of cash received from spazas	Was not considered to have been a problem at the time of evaluation
To reduce the costs associated with phone orders	A success

presents a summary of the evaluation of each of the success criteria described in section 9.1.1:

Success Criteria	Evaluation
To have increased efficiency	A success when considering the three sub-points
To reduce the amount of driving that the field staff are required to do	Unsuccessful by choice of TTO
To improve the flexibility of the order sheet in terms of updating items and prices	A success although not utilized fully because of spaza notification constraints

To increase the field staff's access to information, in particular: <ul style="list-style-type: none"> • Order Totals • Spazas' Account Balances • Transaction Fees 	A success in all aspects
To reduce the workload spikes for administration staff	A success
To improve the recording of cash received from spazas	Was not considered to have been a problem at the time of evaluation
To reduce the costs associated with phone orders	A success

Table 12 - Interview Summary

The result of this is that Research Question One can be answered in the affirmative. TTO was positively affected by this ICT intervention.

As supporting evidence of the continued use of the system, the following graph (Figure 24) shows the number of orders submitted per order day over a period of almost seven months with a total of 263 orders taken:

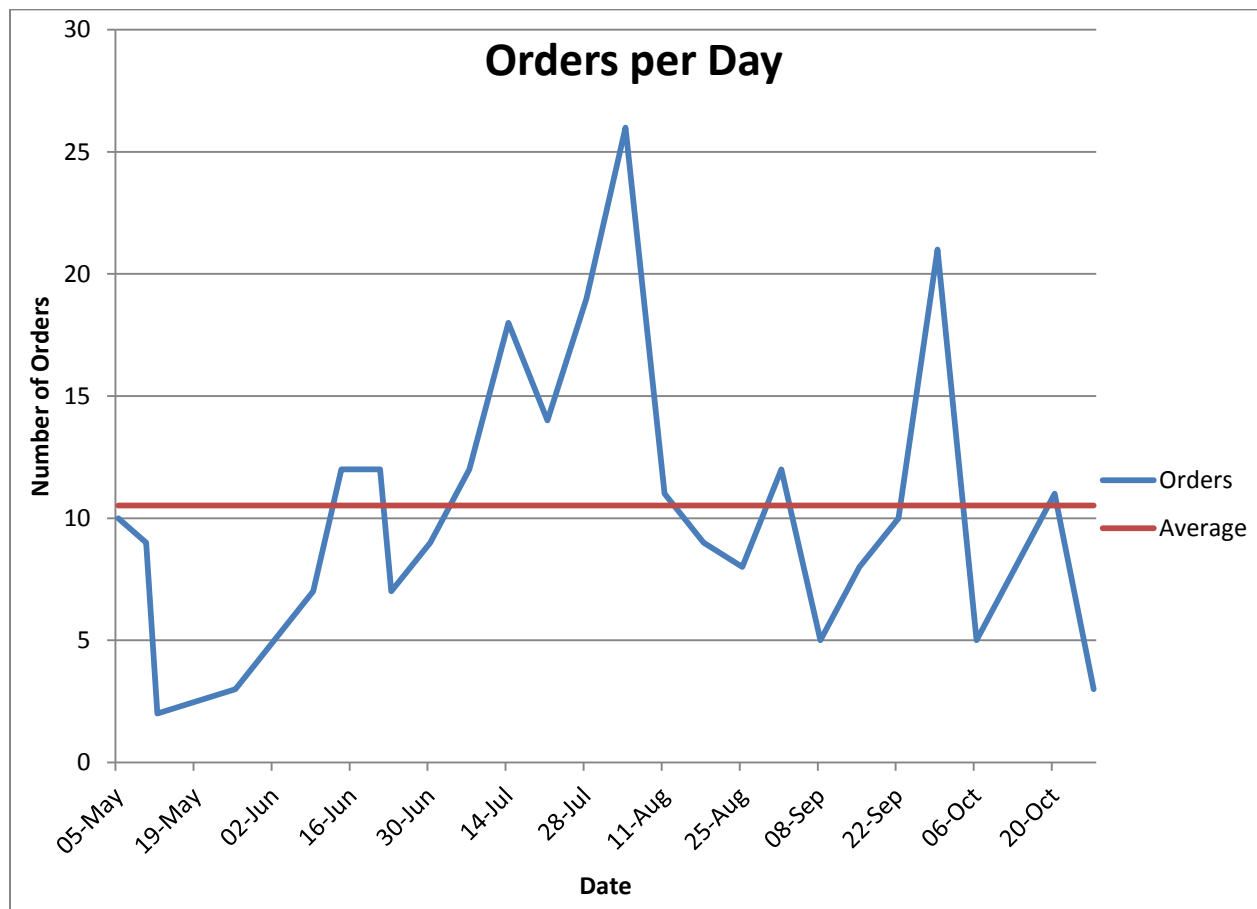


Figure 24 – Graph Showing Orders Taken Over a Period of Seven Months

A discussion of Research Question Two follows.

9.4. Discussion of Research Question Two

Gitau and Marsden (Gitau and Marsden, 2009) postulate that NGOs can, and should, contribute towards the design and evaluation of ICT interventions they are involved in. We now evaluate to what extent TTO generated success criteria for the project in a reflective discussion.

The initial CI with the management was not only a process of discovery for the researcher but for TTO as well. The CI probed the TTO management for goals and priorities that were not yet concrete, but in the process of being established. This took approximately four months. During this time, no evaluation approach could have been suggested because the goals of the ICT intervention had not been finalized.

In terms of generating and understanding evaluation goals, this was a process that developed throughout the duration of the project. Initially the only explicit success criterion was to have increased efficiency. Although explicit, this was still an ill-defined goal. Other than that, success criteria were implicitly stated in the form of expected benefits. There were no success criteria attached to any of the expected benefits, making it difficult to evaluate when these benefits had been realized.

Once the system was being used regularly in the field, the actual benefits started becoming prominent while some of the expected benefits fell away. This helped to clarify what it was that the system was offering from an organizational change point of view rather than from a simple functionality point of view.

This in turn helped to clarify aspects of the initial goals such as what “increased efficiency” actually meant for the organization. It was only in the final evaluation interview with the management that this was communicated clearly for the first time. The point is that the success criteria started out as vague, implicit goals and grew in clarity throughout the project. Even at the end of the project, some of the goals were still somewhat vague, such as “increased form flexibility”.

In this case, the NGO did generate success criteria that were useful in evaluation. They were not as well-defined or as explicit as one might have hoped for, but they were present. When working with NGOs, researchers may have to settle for initially-vague goals and success criteria.

In summary, Research Question Two can be answered positively since TTO did generate success criteria for the project even though it was a process that spanned the duration of the project.

Using the NGO to evaluate this project on their terms was successful. The NGO contributed in generating success criteria and then evaluating the project according to those criteria. The results of the evaluation were positive, as they felt that the project had been a success. A conclusion and reflection follow.

10. Conclusion

The conclusion contains a summary of the work done during this project and a discussion on the evaluation approach, followed by a reflection on partnering with an NGO and on the methods employed, and ends with points for improvement and future work ideas.

10.1. Summary

The project began with a CI at TTO primarily with their management and field staff, shaping the direction of the project. After gaining insight into the ordering process through the CI and prototyping, a PD workshop was held to include the staff in design. After reluctance from the staff, a high fidelity prototype was developed and a CME performed with the field staff. After refining the prototype, the system was tested in a pilot study. Intermittent use of the system grew into regular use over time while improvements were made to it. The final evaluation interviews were then conducted.

10.2. Discussion on Evaluation

In section Discussion of Research Question Two 9.4, TTO's lack of priorities and goals for this project was mentioned. This is not because TTO is a young organization or that there was no plan or goals for the organization. It was because TTO was not expecting an ICT intervention. The fact that TTO was not looking for an ICT intervention, but was rather offered one, is a contributing factor to their lack of goals and priorities for this work. Since TTO was not planning or expecting to be engaged in an ICT-related research project, it is understandable that it took some time to decide on goals and success criteria.

A theme in section 9.4 is the vague nature of the success criteria. Vague success criteria pose a problem to researchers because they run the risk of evaluating the wrong problem. This is where the NGO being involved in evaluation becomes helpful. In this case, "increased efficiency" was too vague for the researcher to evaluate appropriately. TTO understood though what they meant by it and they were in a position to evaluate it appropriately. The NGO is therefore in a position to evaluate vague goals, because they have in mind what is important to them and can evaluate improvements even if these goals are not communicated to or understood clearly by the researcher.

When referring to an evaluation approach for research partnerships with NGOs, Gitau and Marsden (Gitau and Marsden, 2009) suggest that "such a partnership must not be entered into until such evaluation methods exist" in order to protect both the researcher and the NGO. In this case, a lengthy CI was required before such an evaluation method could have been established. Although the benefit of agreeing on evaluation methods prior to a partnership is noted, such an agreement is not always possible without a commitment of time and effort to reach that point. In the case of this project, that time and effort commitment was at least four months.

When Gitau and Marsden (Gitau and Marsden, 2009) involved the NGOs they were working with in evaluation, the NGO management was interviewed to determine the success of the intervention. During work with TTO, it became apparent that different groups of people at TTO wanted different things from the system, and therefore had different success criteria.

For example, reducing the number of mobile phone calls made to the field staff during the day was not a high priority for the management, but it was for the administration staff. Reducing the time spent on the phone to the field staff increased the amount of the time the administration staff could spend on other tasks during order days. Another example is that the participatory conversation between the researcher and the field staff throughout the project was important to them, but not to the management.

The recommendation is that evaluation should be performed not only with the management of an NGO but with the different groups of people involved in and affected by the system.

10.3. Reflection on Working with an NGO

The following is a reflection on the experience of working with an NGO, highlighting some positive and negative experiences.

Working through an NGO is the only way that this work could have made any sort of meaningful contribution to spazas without a great effort in finding and working with individual spazas. In terms of the ability to impact a large number of spazas, working with an NGO was essential. This interaction with the spazas was also mediated through the field staff.

TTO also acted as a cultural intermediary. The spaza owners are predominantly Xhosa and Afrikaans, making it a challenge for an English researcher. TTO's staff work in a multi-cultural environment at the office and in the field and are able to engage with people from these cultures. This enhanced their ability to mediate interaction. This mediation is more than just a language mediation, and extends to cultural practices when greeting or showing respect, amongst other aspects.

Communication with TTO was not always easy though. Emails were regularly not replied to, and responses were often slow. Advice received from a more experienced researcher prompted more communication via phone or in person rather than via easy-to-ignore emails. Communication with TTO was a source of difficulty during the project. In future, this would be a point to improve on, by communicating more in person.

TTO's interest and involvement in the project also seemed to wax and wane. TTO's pattern consisted of bursts of interest and activity followed by periods of silence. Having said that, they were enthusiastic to begin the project and to give their time during the CI.

It was initially a challenge to determine what it was that TTO wanted from this project. There was excitement about many ideas but not time to do them all, and a priority needed to be established. The turning point that led to some clarity was when the discussion changed from potential ideas to TTO's priorities. This also helped to manage expectations.

There is also a sense of satisfaction in getting to know a group of people and having a visible impact on the way they work.

10.4. Reflection on Methods Used

The UCD methodology and various associated methods were employed for this project. A reflective discussion on the appropriateness of these methods follows.

The CI was valuable in understanding both the management and the field staff's perspective on the ordering system. It was also helpful in building relationships with the people at TTO, which was important throughout the project in helping to build participation, feedback and a willingness to be involved. CI is a tool that provides value beyond user requirement elicitation and was an appropriate tool for the task. In future, an attempt will be made to speed up the CI process since the rest of the project waits for direction from it.

The PD workshop did not go according to plan. From a functionality discussion perspective it was somewhat successful, but not in terms of user interface design. The staff did contribute towards the design of the system further than simply stating needs though. This was demonstrated through ideas such as using hierarchical stock-grouping or a searchable list rather than just a scroll list. This shows that they were engaging with the problem of design even if they were not interested in participating in the design of the user interface.

What supports the success of PD in this project is that the field staff mention this specifically as the reason for the success of the project. It was an interesting comment after the initial limited interest. Although the workshop itself was not particularly successful, a PD approach throughout the project was successful and appropriate. A more creative approach to encouraging participation may have yielded more helpful results. Considering the way the field staff thought through problems, role-playing (Jones and Marsden, 2006) may have been a more appropriate alternative.

The CME was successful in that there was keen participation from all but one of the staff and it provided a clear set of changes to make. It was also a helpful tool in identifying unclear and ambiguous design decisions made by the designer. The resulting system, after the problems had been addressed, was one that matched the field staff's conceptual model of the system closely, and was therefore easy to learn and to use. This was an appropriate method and one of the more successful methods employed during this project.

Document Ethnography was helpful in linking together different parts of the ordering-process described by different people. Following the actual document provided a safeguard against aspects of the ordering process being left out in descriptions. This is an appropriate method for understanding a document's lifecycle.

Heuristic Evaluation was helpful in pointing out areas of best-practice that had been neglected by the designer. It is easy to become focused on the implementation of the design rather than on the design itself, so it was helpful having an expert not involved in the design of the system to perform the evaluation.

The training of the field staff prior to the pilot study was unsuccessful in that the staff were not yet fully comfortable with the system after the training. More planning was required from both parties. The lack

of equipment and the time constraints of the training further detracted from it. One positive is that it helped to cultivate the sense of group sharing and mutual help between the field staff members.

10.5. Future Work

An interesting avenue of future work would be to pursue one of the original ideas of the project, specifically, expanding the mobile stock-ordering system to run on feature phones so that it is accessible for the spazas to run the application on their own mobile phones. This is also the direction that TTO wishes to explore because it places the responsibility of ordering back on the spazas rather than the field staff providing the initiative.

An in-depth study of the needs and requirements of the spazas and suppliers would also be a valuable addition to this work and would allow for an ICT intervention that more closely matches the needs of all the stakeholders.

Additional work could also be done towards interfacing the accounting package with the stock-ordering system. This would remove the intermediate files and the administration staff's need to maintain those files and would provide a more unified digital ordering system.

Mobile-based payment methods such as M-PESA (Hughes and Lonie, 2007) could also be added so that spazas and field staff can avoid the difficulty and security concerns associated with cash payments.

Moving further away, inventory tracking and even mobile record-keeping could be added to this system. Since mobile phones are more common than computers in Africa (ITU, 2010), this remains an interesting and, as far as we are aware of at the time of writing, a novel research avenue.

10.6. Sustainability

Sustainability is an important topic, especially in an ICT4D context where many ICT interventions have some early success but then fade away quickly once the researchers leave. Heeks suggests that researcher should be increasingly focused on sustainability rather than on pilot studies (Heeks, 2008).

Efforts were made throughout this project to encourage sustainability. The training session was conducted with group participation and sharing in mind to encourage the field staff to help each other learn. Training manuals were also developed to help pass on the skills required to use the system. With the experience that the current field staff and administration staff have, training new staff should not be difficult. Towards the end of the project, one of the field staff was assigned to other work and a replacement staff member moved to taking orders using the new stock-ordering system. The process of skills transfer had already begun before the researcher had left the project, and this was initiated and being conducted by TTO and not the researcher.

From a technical point of view, the mobile application itself was hosted online so that TTO staff could download and install it on devices in the future. The only technical sustainability issues that might cause problems in the future are if the server application or file structure is lost, or if Dropbox shuts down and the mobile client is no longer available for download. Both the server and client code will be made available to TTO on a more permanent storage device such as a CD.

TTO is currently using the system every order day and it has replaced the paper ordering system for those field staff using the system. It has become a part of their process and they intend to continue using it. The level of ownership that TTO has displayed in wanting to deal with issues without being helped by the researcher, combined with the experience the staff have gained over the past seven months of using the system suggests that they will be able to carry the project forward in a sustainable way.

At the time of writing, the core process of TTO had been improved rather than altered significantly. Potential future work in this direction, described in the following paragraph, could significantly change TTO's process if that is the direction in which they want to move.

Now that TTO has seen what is possible through an ICT intervention, if they have further access to a researcher, their goal is now to move towards the shop owners using the system themselves rather than the field staff. If this is the case then this project in its current form might have a short lifespan by choice rather than through poor sustainability.

There has been negligible economic impact from the project to date since the greatest costs to TTO of staff remuneration and petrol costs have remained. It is only really if future work is pursued to put the system in the hands of the spaza owners that there would be a significant economic impact. This evaluation is out of scope of this work though.

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Appendices

The following are the appendices referenced in the body of the text of this thesis.

Appendix A

This appendix shows the range of transaction fees charged by TTO for each order according to the order total.

Amount ordered (Less than x Rand)	Fee charged in Rands
0	10
300	10
400	18
500	23
600	28
700	33
800	38
900	43
1000	48
1100	53
1200	58
1300	63
1400	68
1500	73
1600	80
1700	87
1800	94
1900	102
2000	110

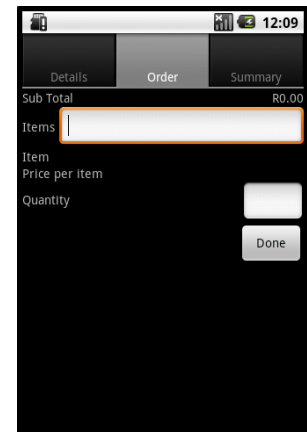
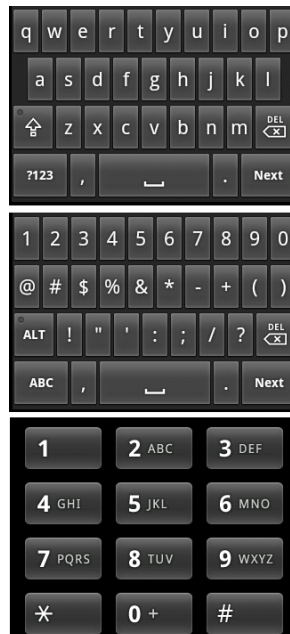
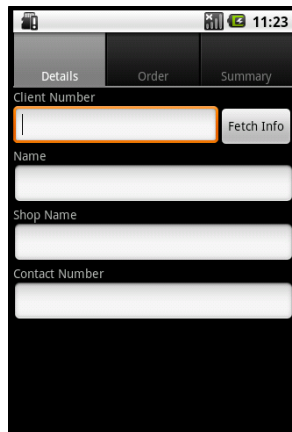
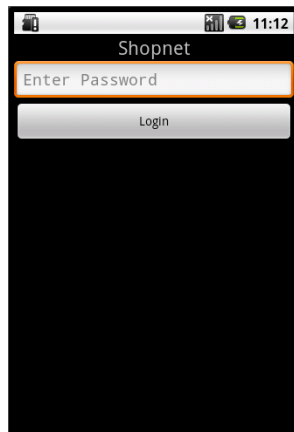
Appendix B

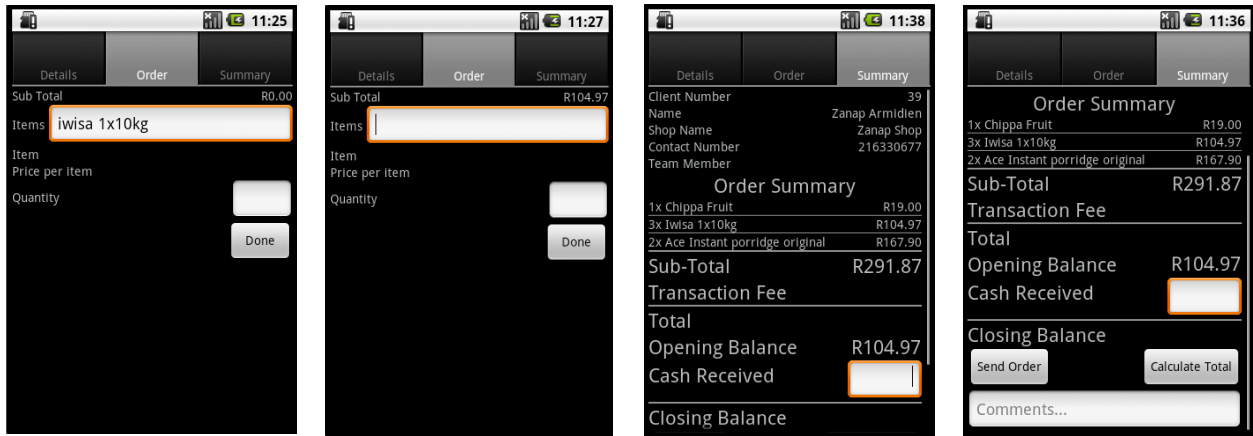
This appendix shows a portion of the paper order sheet as at the start of this project. The full order sheet had 209 items at the start of the project.

NAME															
SHOP NAME															
CLIENT NUMBER															
CONTACT NUMBER															
PRODUCT	PRICE	UNIT	TOT	PRODUCT	PRICE	UNIT	TOT	PRODUCT	PRICE	UNIT	TOT	PRODUCT	PRICE	UNIT	TOT
Ace Instant porridge banana	90.00		0.00	Flyers one flavour	31.00		0.00	Rooibos strips	55.00		0.00				
Ace Instant porridge original	90.00		0.00	Frisco 6x100g	46.00		0.00	Rothmans 10	55.50		0.00				
Ace Instant porridge strawberry	90.00		0.00	Glen 12x26	39.80		0.00	Rothmans 20	55.50		0.00				
Albex 12x750ml	67.00		0.00	Glen strips	32.00		0.00	Royco pkt soap beef	23.50		0.00				
Always sanitary towels 4 x 9	42.00		0.00	Golden Cloud Flour 1x10kg	51.25		0.00	Royco pkt soap brown onion	23.50		0.00				
Aromat 10x75g	61.00		0.00	Grand-Pa 38s	25.40		0.00	Royco pkt soap chicken	23.50		0.00				
Aromat 10x75g Chili	61.00		0.00	Hulett's 10x1kg	83.65		0.00	Royco pkt soap cream mushroom	23.50		0.00				
Aromat sachets 20 x 15g	34.00		0.00	Hulett's 15x500g	65.30		0.00	Royco pkt soap Minestrone	23.50		0.00				
Aromat sachets 20 x 15g chilli	34.00		0.00	Hulett's 1x10kg	81.00		0.00	Royco pkt soap oxtail	23.50		0.00				
Ashwood / Hilux 1x24	44.00		0.00	Hulett's 20x250g	47.95		0.00	Saldanha Chilli 12x410g	124.45		0.00				
Baked Beans Koo 12x410g	66.30		0.00	Hulett's 4x5kg	144.00		0.00	Saldanha Chilli 24x215g	158.00		0.00				
Baked Beans Koo 6x410g	33.15		0.00	Hulett's 8x2.5kg	158.00		0.00	Saldanha Tomato 12x410g	124.45		0.00				
Bath lux white	42.85		0.00	Imana beef stock	33.65		0.00	Saldanha Tomato 24x215g	158.00		0.00				
Bath Soap Sunlight 12x125g	34.65		0.00	Imana beef stock chilli	33.65		0.00	Seepo Salt 20x500g	31.00		0.00				
Bonnita milk 10 x 500ml	51.00		0.00	Imbo Beans 10x500g	60.20		0.00	Seepo Salt 40x500g	51.50		0.00				
Bonnita milk 6 x 1 litre	51.00		0.00	Imbo Lentils 10x500g	72.45		0.00	Smoothies supa mint	7.00		0.00				
Bull Brand Corned beef 6x300g	66.30		0.00	Imbo Soup Mix 10 x 500g	56.00		0.00	Smoothies supa banana	152.00		0.00				
Cadbury Mini chocs 24s Lunch Ba	36.50		0.00	Imbo Split Peas 10x500g	59.20		0.00	Smoothies supa custard	72.00		0.00				
Cadbury Mini chocs 24s PS	36.50		0.00	Invicta Samp 10x1kg	45.95		0.00	Smoothies supa lemon	7.00		0.00				
Cadbury Slabs 12 x100g Dairy Mi	85.00		0.00	lwisa 10x1kg	45.90		0.00	Smoothies supa mango	7.00		0.00				
Cadbury Slabs 12 x100g Fruit an	85.00		0.00	lwisa 1x10kg	40.25		0.00	Smoothies supa melon	16.00		0.00				
Cadbury Slabs 12 x100g Top Deck	85.00		0.00	lwisa 4x5kg	78.55		0.00	Smoothies supa strawberry	7.00		0.00				
Cadbury Slabs 12 x100g Whole N	85.00		0.00	lwisa 8x2.5kg	81.00		0.00	Snack-A-Tac BBQ	20.00		0.00				
Cadbury Slabs 12x100g Mint	16.00		0.00	Joko 6x26	37.75		0.00	Snack-A-Tac Cheese	20.00		0.00				
Casemia Biscuits	19.50		0.00	Joko strips	43.85		0.00	Snack-A-Tac Mix	20.00		0.00				

Appendix C

This appendix shows the images used in the CME.





Appendix D

This appendix shows the questions asked in the CME, with the corresponding slide numbers.

Password Screen

1. If you wanted to type in this box, how would you do it? [SLIDE 1]
2. If you wanted to log in, what would you do?

Keyboard Choice

3. If you wanted to type in a shop name, what keyboard would you want? [SLIDE 2] then [Slide 3]
4. If you wanted to type in a client number, what keyboard would you expect? [Slide 2] then [Slide 3]

Details Screen

5. If you wanted the phone to get the shop information of a particular shop, how would you do it? [SLIDE 2]
6. If you wanted to start taking an order, what is the first thing you would do?

Order Screen

7. If you wanted to order Iwisa 1x10kg, how would you start doing that? [SLIDE 4]
8. If you had Iwisa 1x10kg in the field, what would you expect the “item” and “price” to show? [SLIDE 5]
9. How would you add 3 of this item to the order?
10. How would you add another item to the order? [SLIDE 6]
11. How would you change the iwisa order to only have 2 instead.
12. If you wanted to see the whole order form, how would you do it?

Summary Page

13. Where do you expect the shop information came from? [Slide 7]

14. Is it easy to tell what the order consists of?
15. Whose opening balance is this?
16. How would you record how much cash you received from the shop owner?
17. How would you figure out how much the transaction fee is? [Slide 8]
18. How would you total the order?
19. How would you figure out the closing balance?
20. How would you send the form to the office?
21. Would you need to total the order before sending it to the office?
22. What would happen if you accidentally pushed the "Send Order" button?

Appendix E

This appendix contains the administration staff's user manual. Formatting of the document has been changed to fit the formatting of this document.

User Manual

For creating server forms

There are 3 files that need periodic updating and 1 file that can be changed if necessary. The files must be named as they are in this document. If they do not have the same name or are not in the .csv format, the server will not work. The files are as follows:

1. Order.csv

This file contains the price list of all the items with their corresponding prices. It should look like this:

	A	B	C
1	Product	Price	
2	Ace Instant porridge banana	83.95	
3	Ace Instant porridge original	83.95	
4	Ace Instant porridge strawberry	83.95	
5	Albex 12x750ml	65.95	
6	Always sanitary towels 4 x 9	38	
7	Aromat 10x75g	60	
8	Aromat 10x75g Chilli	60	
9	Aromat 20 x 15g chilli	1	
10	Aromat sachets 20 x 15g	1	
11	Aromat sachets 20 x 15g chilli	1	
12	Ashwood / Hilux 1x24	46	

The 2 columns are "Product", then "Price" in that order. They must be in column A and B with the headings in row 1 and the items starting from row 2. There can't be any spaces between items.

2. Service Charge.csv

This file contains the transaction fee information. It should look like this:

	A	B	C
1	Amount ordered (Less than x Rand)	Fee charged in Rands	
2	0	10	
3	300	10	
4	400	18	
5	500	23	
6	600	28	
7	700	33	
8	800	38	
9	900	43	
10	1000	48	

As with Order.csv, the first 2 columns are used with the first row as headings. (It does not matter what headings are given) The values are read from row 2. This is how it works:

1. Order amounts between consecutive cells are given by the value associated with the lower cell. For example: if the order amount is R740, the transaction fee will be R33.
2. Order amounts greater than the last order value in the list will be given by the highest transaction fee. For example: if the sheet above is the entire sheet, then an order amount of R1600 will be given a transaction fee of R48.
3. The lowest order amount must be 0 in cell A2. This is to allow orders less than the amount given in cell A3.

It will be TTO's responsibility to make sure that the order amount brackets are high enough so that shop owners don't exceed the highest bracket and get an effective discount on their transaction fee.

3. Details.csv

This form contains all of the spaza shop information. It is the most frequently updated form because it contains the opening balance information of the spaza shops. It should look like this:

	A	B	C	D	E	F	G	H	I	J
1	Balance	Company	M.I.	Phone	Fax	Contact	Street2	City	Note	
2	44.34	Siphesihle Spaza	1205	837209066		Mrs Nophelo Mane	38604 Cha	Harare	buli	
3	2.9	Ndinga Cash Store	234	849380434		Mzukisi Sosi	41 129 Mh	Makaza	buli	
4	67.19	Kwa Makazi Cash Store	2352	735904950		Miriam Koleka Mpande	55 256 Mk	Kuyasa	buli	
5	237.48	Siiza	2407	719467168		Nyameko Luningo	W536 Mat	Site B	buli	
6	52.85	Hasana Spaza	2557	724662020		Mr Bukula	39 910 Has	Makasa	buli	
7	-56.14	Amaxesibe Cash Store	2597	739911521		Nolwazi Dike	32B 412	Makaza	buli	
8	-24.61	Miya Cash Store	2598	787460437		Thokozile Mdiya	32 B 228 F	Makasa	buli	
9	-54.06	Zibula's Cash Store	2602			Dumisani Madubela	A553B Zol	Site C	buli	
10	-41.05	Siyazama Cash Store	2608			Shirley July Mtyalela	23 226 Duf	Makhaya	buli	
11	621.52	Mofukeng Spaza	2454	716433690		Nandipha Koza	6248 Jack	Samora	buli	
12	-0.01	Kwa Mzondi Spaza	2455	783085655		Malibuye Xelani	5112 Joe S	Samora	buli	

The 1st row is used for headings with the information starting in the 2nd row. It is very important that the columns stay in this order. If they are not in this order, the server will not work.

The following are the important columns:

- A. Balance (opening balance)
- B. Company (spaza shop name)
- C. M.I (client number)
- D. Phone
- F. Contact
- I. Note (field staff's name)

These values **must** be in these columns. The names of the headings are not important though as long as the data is in the correct columns.

Important Notes:

1. This file **must** be kept up to date. If it is not, the opening and closing balances will be wrong on the phones and the order forms saved by the server.
2. It is very important that the "Balance" column is saved as a "text" type and **not** a "number" type. This is because the negative balances must be saved as "-56.14" in cell A7 and **not** as "(56.14)". Also, large balances must be saved as "1290.30" and **not** as "1,290.30". There must be no commas in the value.

4. **server_data**

This file only contains 1 value and is not easily changeable, since it has no extension. This is to stop people accidentally changing it. The value this file contains is the invoice number of the next invoice the server will produce. The only time this file needs to be changed is if the invoice indexing needs to change. The file can be modified by opening it in wordpad or notepad or any normal text editor.

Running the server

To run the server, go the "Shopnet" folder (or whichever folder contains the file "cgi_server.py"). Double click on "cgi_server.py". A screen will come up that says "CGI Server running and waiting for requests...". That means that the server is running and will save forms and handle requests made. This must always be running if you want to be able to receive forms.

Important Note:

It might be possible for 2 different invoices to be saved with the same invoice number. This is extremely unlikely and will probably never happen, even if it is possible. If it does happen, send me an email and I'll make a change that should help.

Errors while using the phone

The following is a list of errors, likely causes, and probable solutions:

1. **UnknownHostException:** This means that the phone cannot find the server. Either the phone does not have signal or the server is not running. If the server is not running, simply start it (as described above in the “Running the server” section).
2. **SocketTimeoutException:** If this happens, it will usually happen about 10 seconds after pushing a button that requires the server or starting the application. Make sure the server is running and that the phone has signal.
3. **JSONException:** This could either be bad luck and the staff member just needs to try again, otherwise it means that there is a field in one of the forms that is blank or unreadable but shouldn't be. An example would be if a spaza shop's opening balance is missing or incorrectly formatted.
4. **Server can't calculate transaction fee:** Check that the “Service Charge.csv” file is there and that it doesn't contain formatting errors. (described in the 1st section of this document)
5. **Could not submit form:** This could be because of error number 1 or 2. Do the same checks as for those errors.
6. **Server could not find order form:** Check that the “Order.csv” file is there and that it doesn't contain formatting errors. (described in the 1st section of this document)
7. **No client found with that number:** The client number does not exist in the “Details.csv” file.

Note: Other errors are possible but unlikely. They are probably not errors that can be solved quickly by TTO staff. In that case, if they are persistent, phone me or email me.

Appendix F

This appendix contains the field staff's user manual. Formatting of the document has been changed to fit the formatting of this document.

“How-to” for field staff

There are only 7 functions that can be performed using the system:

1. Logging in
2. Getting client information
3. Adding an item to the order
4. Updating/removing an item from the order
5. Viewing an order summary
6. Totaling the order
7. Sending the order

If you are comfortable with each of these, then ordering should be easy.

1. Logging in

1. Touch the “Enter Password” text field. A keyboard will come up.
2. Type in the password
3. Touch the “Login” button

2. Getting client information

1. Touch the text field under “Client Number”. A keyboard will come up.
2. Type the client number
3. Touch the “Fetch Info” button to the right of the field

3. Adding an item to the order

1. Touch the “Order” tab at the top
2. Touch the text field next to “Items”. A keyboard will come up.
3. Type in the first few letters of the item you want.

After the first letter is typed in, a drop-down menu will appear with all the items that match the text so far. The more you type, the fewer items will be in the list. See the section on “Using an Android phone” for how to use the list.

4. Touch the item you are looking for from the dropdown list. A keyboard will come up.
5. Type the quantity of that item you want to order
6. Click “Done” on the keyboard to remove the keyboard. Alternatively you can push the back button on the phone.
7. Click the “Add Item” button.

This item has now been added to the order

4. Updating/removing an item from the order

1. Touch the text field next to “Items”. A keyboard will come up.
2. Type in the first few letters of the item you want.

After the first letter is typed in, a drop-down menu will appear with all the items that match the text so far. The more you type, the fewer items will be in the list. See the section on “Using an Android phone” for how to use the list.

3. Touch the item you are looking for from the dropdown list. A keyboard will come up.
4. Touch the delete button on the keyboard to remove the current quantity value
5. Type the new quantity you want to order (type 0 if you want to order none of it. i.e. remove the item)
6. Click “Done” on the keyboard to remove the keyboard. Alternatively you can push the back button on the phone.
7. Click the “Update Item” button to update/remove the item

5. Viewing an order summary

1. Touch the “Summary” tab at the top

To move the screen up or down, slide your finger up or down on the screen.

See the section on “Using an Android phone” for how to slide the screen.

6. Totaling the order

1. In the “Summary” tab, touch the “Calculate Total” button which is towards the bottom right of the screen.

It sometimes takes a few seconds to connect to the server.

7. Sending the order

1. Touch the “Send Order” button which is towards the bottom left of the screen.
2. A confirmation dialog will appear. Touch the “Yes” button if you wish to send the order or the “No” button to go back.
3. Click the back button on the phone to exit the application and reset the form for the next order.

Using an Android phone

Using touch-screens can be difficult at first, but once you get used to them, they can be quite nice.

Tips

1. If you are struggling to click the right button or type the right letters, try using the back of a pencil instead of your finger. A pencil is thinner and can be more accurate.
2. Don't panic if you can't do something the first time. This is more like a computer than you might realize.

“How-to”

1. Click buttons

Touch your finger on the button and then pick it up again without moving it around. This is like clicking a button with a mouse on a computer

2. Make a keyboard appear

If you want to type in a field but there is no keyboard, just touch the field and a keyboard will come up for you.

3. Slide the screen up and down

Touch the screen with your finger but don't pick your finger up. With your finger still on the screen, slide it up and down the screen. What the screen displays will follow your finger. It's as if the page is stuck to your finger and you're sliding the page around. Once you have moved the page enough, take your finger off the screen.

4. Use the drop-down menu in the Order section

This is probably the most difficult thing to use. Once you've entered in a letter, the drop-down menu will appear. There are only two things you can do with this menu: click it, and slide it. You need to be comfortable with clicking and sliding before you can use this.

To make the whole menu appear, you need to **slide** the menu up or down, **not** click it. Either way will show the menu. So, touch your finger on the menu but **don't** pick it up. Slide the menu a bit and only then pick your finger up. As long as you don't pick your finger up, you can slide the menu as much as you like and it won't select an item.

Once you've found the item you want, then click on it as described in point 1 of this section. This will complete the text in the field and make the menu disappear. To select another item now, you will need to delete what is in the text field and start again.

Plagiarism Declaration

1. I know that plagiarism is wrong. Plagiarism is using another's work and to pretend that it is one's own.
2. I have used the ACM style of referencing and the author-year style for citations. Each significant contribution to, and quotation in, this thesis from the work, or works of other people has been attributed and has been cited and referenced.
3. This thesis is my own work.