

# Mobile Applications for Informal Economies

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**Abstract**—The proliferation of mobile phones across the world, to people of all statures, has provided platform to bring computing resources to the masses. In this paper we present three mobile phone applications designed to aid the businesses and people of informal economies in developing countries. The goal of the applications is to assist in the growth of the economy through financial education and awareness and to assist and further the literacy. Each application is motivated and inspired by the needs of the women at the Saint-Louis Women’s Business Center Incubator in Senegal, Africa. We present the motivations, application design and operation, and the lessons learned throughout a year of development.

## I. INTRODUCTION

In this paper we present the research and the applications developed over past year by participants of Stony Brook’s Advanced Topics in Computer Science Seminar on Mobile Computing for Informal Economies [1]. Our first goal was to develop Mobile Phone applications for businesses connected with the Women Business Center (WBC) located in Saint Louis, Senegal [2], [3].

Senegal is located in West Africa. The most popular languages are Fula and Wolof, with several million speakers each. French remains the official and educational language. Senegal counts 3.37 millions of mobile phones subscribers - representing 28% of the country population. The access and presence of the Internet and Web is limited due to infrastructures, education, and language issues.

NCNW (National Council of Negro Women) is a US NGO that was established in 1935 with headquarters in Washington DC. NCNW has been operating in Senegal (Dakar, Thies and Saint Louis) since 1975. Main areas of activities are education, health and economic empowerment of women. The Saint-Louis office houses the Women’s Business Center (WBC). In summer of 2008, the Center supported seven women entrepreneurs as resident clients. All women had never had contact with a computer before the program and were learning to use it for their businesses. The resident training program was designed to teach computer use, accounting, marketing, management, assist in the creation of a business plan and provide access to Internet.

Incubators typically are funded for a limited amount of time, and the incubator clients are aided for short periods of the Incubator’s lifetime. One drawback of the program is that the technology which the incubator clients learn to use is only accessible to them during their stay with the program. After the completion of the program it is essential to provide the clients with a support structure to continue using the principles and

practices they have learned. In most cases the clients do not own or have access to a computer. However, almost all own or have access to mobile phones. Based on this, we decided to develop mobile applications that would allow the incubators’ clients to continue to run their businesses the way they were taught and became accustomed to while collaborating with the incubator and hence to improve incubators’ sustainability in the countries they are located.

### A. Stony Brook Seminar

The participants of the seminar were presented with detailed profiles of all of the clients [4] and it was decided that the women from the incubator needed assistance in two categories: financial management of different kind and educational goals set up by ADD- Neighborhood Association program situated in the poorest area of St. Louis.

The goal of the seminar was to address the needs of the women in Senegal by building applications to aid and educate the informal economy business of basic financial principles/consciousness. Also, since the situation in Senegal is not unique, we aimed to develop applications which could also be use in other informal economies in other countries all over the world. Also, since many informal economies function in areas with different spoken languages and written languages and in areas where the illiteracy rate is high, we also aimed to develop the applications to be primarily visual-based, and therefore natural-language independent.

We have used J2ME, developed prototypes on emulators and installed them on provided phones and our own phones. The prototypes were then tested in January 2009 in St Louis, Senegal with women connected Women Business Center (WBC) and with Dakar’s Middle School children. They were also shown to the Thies’ University Bootcamp students who finally developed their own applications tailored to particular users [5], [6], [7], [8], [9], [10], [11].

These prototypes were presented in February 2009 at conference “MobileTech for Social Change: A Barcamp by MobileActive.org and Hunter College”, New York, NY [12], [13]. The improved version of the original prototypes was presented in April 2009 at conference “Mobile Technology 4 Social Change”, GOOGLE, Washington DC [14].

Even if concepts for our applications originated in a specific place, our goal was to design them in such a way that they can be used in any part of the world by people speaking many different languages. Moreover, we wanted to address the problem of illiteracy or partial illiteracy of potential users. We

hence looked into development of mobile phone prototypes that target as many informal economies as possible, i.e. to create applications which would be the most universal and easy to use for even illiterate users.

To achieve these goals we looked into the development of applications with fully pictorial, word free, or almost word-free user interfaces. To which the words can be easily added in any language of the country in which the application would be used, if needed. Nevertheless the applications should be fully operational and comprehensible without the natural languages labels attached.

### B. Paper Organization

In the next two sections we present the applications inspired by the needs of the women of the Senegalese Women's Business Center (WBC). We begin by presenting two financial applications, the first is a goal-oriented accounting program and the second is a buy-and-sell for profit application. Then we present an educational dictionary application. For each application, we present the motivation behind the development, the operating functionality, the technical details, and the lessons learned in each case. In Section IV we present the main challenges faced during application development.

## II. FINANCIAL APPLICATIONS

The main goal of the financial applications was to motivate and educate the business owner to be more knowledgeable to business practices. During the interviews with the incubator clients, we learned that many of the women didn't have an idea of hidden expenses. Many of them made no connection between their personal expenditures and the business expenses. For example, during the interview with one of the women business owners, who spoke very rudimentary French, when she was asked how much she paid for rent. She answered, "My brother in law gave me the space and I do not paid rent." When asked "Did you buy a present for your brother in law and how often", she replied "Of Course". Another example is the number of employees she had she responded "None". In the answer to the question that who helps her, "All my children". In the end she made no connections between the money spent on the family members and the connections between the expenditures and the business.

In another case, a more experienced business women was printing business cards, taking taxis to hotels where she distributed these cards, and she was paying money to guides to bring the visitors to her store. She did not consider any of these as business expenses, meaning she did not keep track of the money spent or even realize that these costs impacted her profits. In these two cases and many others, many of the other women had no understanding of knowledge of whether their business were making profits or losing money.

Based on this knowledge, we designed the financial applications to address two main needs. The first is aimed at aiding the women/users in realizing and understanding where the income comes from and what are their expenditures for their business. As mentioned in the introduction, many of the

small business owners were unknowledgeable in terms of their business finances. The second need was to enable business owners who transform raw goods into sellable products and who barter on the prices of the goods to determine their pricing in order to make a profit. In the next two subsections we present the applications developed to address these goals.

### A. Goal-Oriented Accounting Application

The goal-oriented accounting application is designed to perform simple accounting with pre-defined categories of income and expenses. The main motivation for development was to teach and encourage the recording of hidden expenses which many of the business women were unconscious of when interviewed in Senegal. In addition during the interviews many of the women expressed an interest in obtaining larger or expensive items which they normally would not be able to afford, such as a sewing machine. The application is designed to help the user focus their finances towards achieving a long-term goal or purchase by illustrating their savings towards the goal. By providing a simple interface for entering sales and expenses we hope to both educate and increase financial awareness amongst the users.

1) *Application Functionality*: The goal-oriented accounting program is a program that helps the user manage their income and expenditures (outgoing). The main screen shown in Figure 1(a) offers five functions/buttons the user can choose from: Income, Outgoing, Profit, Goal, and Minimum Balance.

When the user chooses Income, which is represented by a blue arrow into the money on the main screen, a screen is presented that allows the user to choose the type of income the user wishes to input (Figure 1(b)). For example, the categories include jewelry, clothing, or art. When the user selects the type of input a new screen is presented where the user can input the amount of money they have received for that category of goods (Figure 1(c)). This is done by simply using the number buttons to input the amount, then pushing the middle button on the phone to save the value. Once done, the user can either use the left menu button to go back to the main menu, or the user can use the right menu button to go back to the previous screen.

After choosing the Outgoing button from the main menu, which is represented by a red arrow out of the money, the user is presented with a screen where expenses can be imputed into the program (Figure 1(d)). For instance, if the user spends money for a taxi, rent, food, and utilities. To input an expense, the user would go to the outgoing screen, use the up and down arrow keys on the phone to move the cursor to the correct expense category, then use the number keys to input the amount of that expense. Once the value is saved then the program shows the balance screen, taking into consideration income and the expenses entered (Figure 1(e)). The balance screen, which is represented by the box with money on the main screen, displays the current information about the money on hand. First, it displays the total amount of the user's profit at the top of the screen. On the bottom half of the screen is

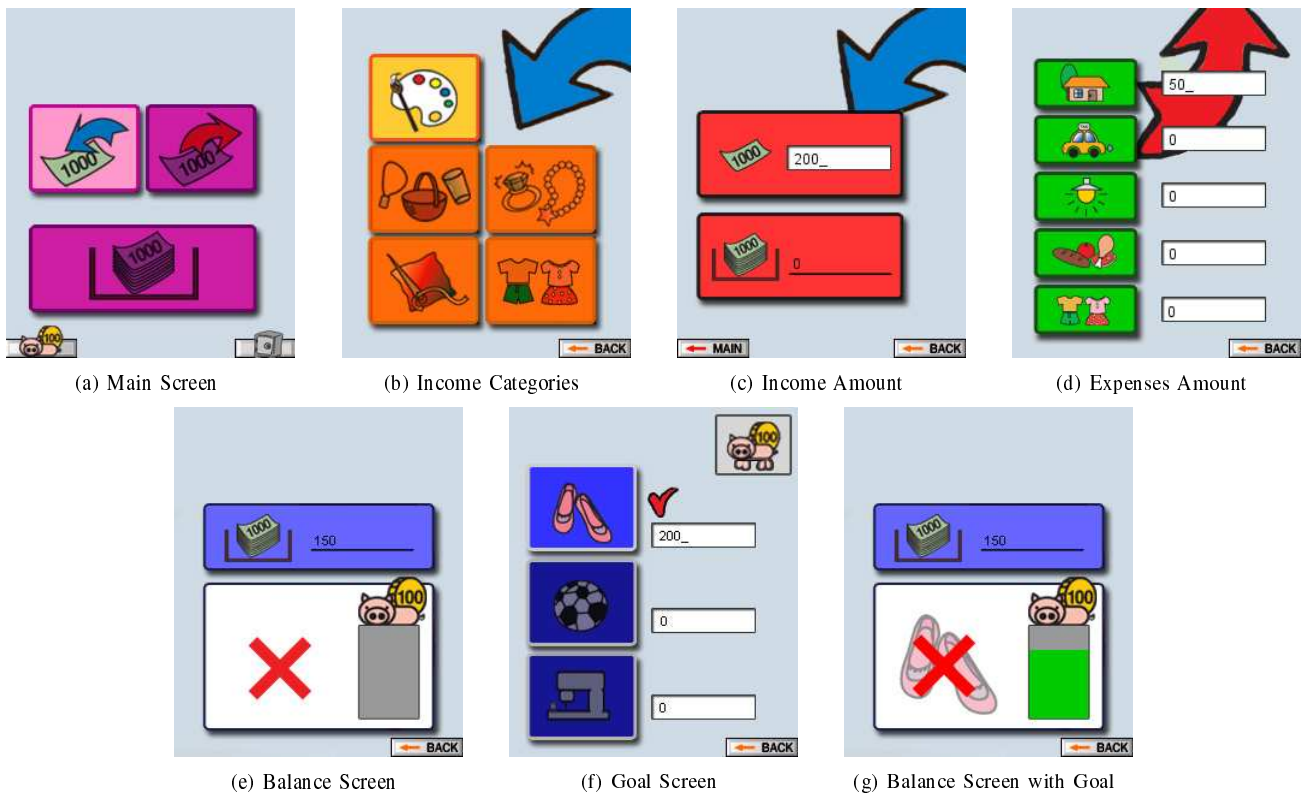


Fig. 1. Screenshots of the financial application.

the the goal box. The goal box illustrates the users progress toward a goal.

From the main menu, the user can use the left menu button to proceed to the Goal screen. The goal screen is where the user chooses a goal to work towards (Figure 1(f)). The goal that the user chooses is displayed in the Profit screen as described above. There are three goal categories: basic, medium, and expensive. The user can choose a goal by using the up and down arrow keys to move the cursor to the correct goal. The user must then input the value of that goal and hit the middle key on the phone to choose that goal. If all goal values are 0, there is no goal chosen and so a red “X” is displayed on the Profit screen as illustrated in Figure 1(e).

If the user selected a goal on the GOAL screen, the profit screen would display the item as shown in Figure 1(g). For example, assume the user chooses the shoes at 200 cost units as the goal. In this case, because there is only 150 units in the balance box, the user has not reached the goal and cannot currently buy the item. Thus there is red-colored “X” mark on the shoe image and the progress bar to the right is not completely filled.

The last button the user can choose from the main menu is the Minimum Balance screen (Figure 2(a)). Minimum Balance is a “security cushion” that prevents the user from having absolutely no money. It is money that should only be used in an emergency, when the user has no more operational balance. This security cushion should also always be replenished if any of it is used. There are three functions that the Minimum

Balance screen has. The first is showing the user a visual of the minimum balance and their profit above that balance. The two are different colors so it is easy to distinguish. Under this horizontal bar is where the user either sets the value for the minimum balance, or replenishes the minimum balance.

If the user has a profit equal to or greater than the minimum balance, then when this screen is opened, the user will be able to set/change the amount of the minimum balance. If the user has a profit less than the minimum balance (the user has spent some of his security money), then when this screen is opened, the user must enter an amount to add to the minimum balance. This is how the program forces the user to replenish the minimum balance. Once the user obtains a profit more than the minimum balance again, when the Minimum Balance screen is opened it will allow the user to set/change the value as before.

If a user has expenditures greater than the profits made, and therefore is borrowing from the minimum balance, then the balance screen will display the negative amount in red and the minimum balance screen will change to display a replenish screen as shown in Figure 2(b). In the progress bar, yellow color means remaining minimum balance and the red color means the minus value in the profit. User can input the replenished amount of money in the box. Once the borrowed amount is entered, the progress bar will change to yellow which means that the minimum balance is restored and the balance screen will again display the profits.

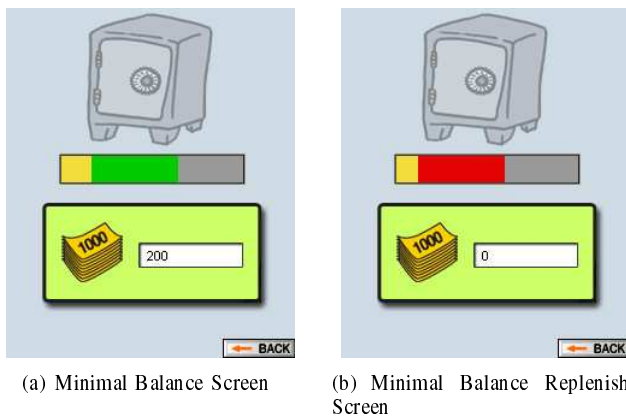


Fig. 2. Additional screenshots of the financial application.

2) *Technical Details:* The financial application maintains all information related to transactions done within the application. Such transactions include financial activities such as monitoring incoming and outgoing money. In addition, the configuration data related to these financial activities are stored into the applications database. The financial application uses the "RecordStore" class within the "javax.microedition.rms" package to store this necessary data [15].

There are two kinds of basic transactions that are stored in the database. First, the user can store the specific amount of income and category of that income - Paintings, Jewelry, Small Items, Clothes and Fabrics for instance. This is considered the incoming transaction. For example, when a user makes money by selling paintings, he/she can select the "Paintings" button and then insert the amount earned from that painting into the application. The application then stores the date and the amount of money earned into its database system using "RecordStore". After this occurs, the application automatically calculates total profit in order to maintain a running total for the user. The application keeps a daily record of the profit made for three months. The second kind of transaction is when the user inserts the amount of money spent on various things such as Rent, Taxi fares, Electric Bills, Food and Clothes. The application then stores the date and amount spent into the database and then automatically calculates the total profit as described earlier.

The database is also used to display its stored data in the application. "RecordStore" is also used in this case. Because there is no specific table or field, the application should keep the data in the same format and same field style. In order to use the same format, the application changes the data to a byte array format. In order to use the same field style, there are date fields and number fields which are specific values for the other function. As described above in the basic transactions, incoming and outgoing, there is a date field and a number field which is the amount of money earned or spent.

Because the high level GUI in J2ME cannot be located at designed position, the financial application uses low-level GUI. However, it does not use components such as text boxes, check boxes or buttons. The application implements each

component with images and coordinates thus the screen can be maintained better since the programmer can set the exact location of each component. By implementing the program in this way the application can easily be modified for other businesses solely by changing the images.

3) *Lessons Learned:* Initially, the application was developed to maintain simplistic functionality. During the bootcamp revisit, a Senegalese student brought the applications to the women and discussed their operation. After a half-day interview with the business owners the student had learned that all of the businesses kept a minimum cash balance for daily operation. The minimum cashier balance was added to the application to meet the needs of the users. In addition, based on the feedback, we also simplified the specification of the goals to allow the user to select a single goal at a time, giving a more accurate view of their achievement along with progress bars to illustrate the achievement.

### B. Buy and Sell for Profit Application

Buy and Sell for Profit is an easy to use application that was originally designed for the purpose of preventing losses in businesses of fisherwomen who buy fresh fish, dry them and then sell the dried fish. During the trip it was seen that the fisherwomen needed an application that would help them in (i) determining the prices with which they should sell the dry fish in order to make profit and prevent losses, and (ii) determining the maximum price of fresh fish to accept from the vendors in order to make a profit.

Hence, the Buy and Sell for Profit application is specially implemented to output the minimum sale price for a given amount of dry fish, with which the fisherwomen will make a profit. Moreover, the application also shows the maximum price to give for a kilo of fresh fish when buying fresh fish from the vendors, in order to make a profit. This application gives a basis for the fisherwomen to bargain with the fresh fish vendors and the dry fish customers, in order to make a profit.

1) *Application Functionality:* When the program starts, a menu with 5 options are displayed to the user. As seen in Figure 3(a), these options are: Sell for Profit, Buy for Profit, Update Fresh Fish Bought, Update Dry Fish Sold and Reset. We explain the use of each of these options.

When the user clicks on Sell for Profit, she is prompted to enter the kilos of dry fish that she wants to sell (Figure 3(b)), after which a screen is displayed telling her that she must sell the dry fish for a price that is more than that which is displayed on the screen, in order to prevent a loss.

If the user clicks on the Buy for Profit option on the main menu, she is shown a screen that tells her that she should buy a kilo of fresh fish with a price that is less than the displayed price, in order to have profit. (Figure 3(c)).

Whenever the fisherwoman sells a certain amount of dry fish for a certain price, she must click on the Update Dry Fish Sold button, and input the kilos of dry fish sold and the amount of money obtained (Figure 3(d) left). Then she should click on "update sale" to update the database. If the database

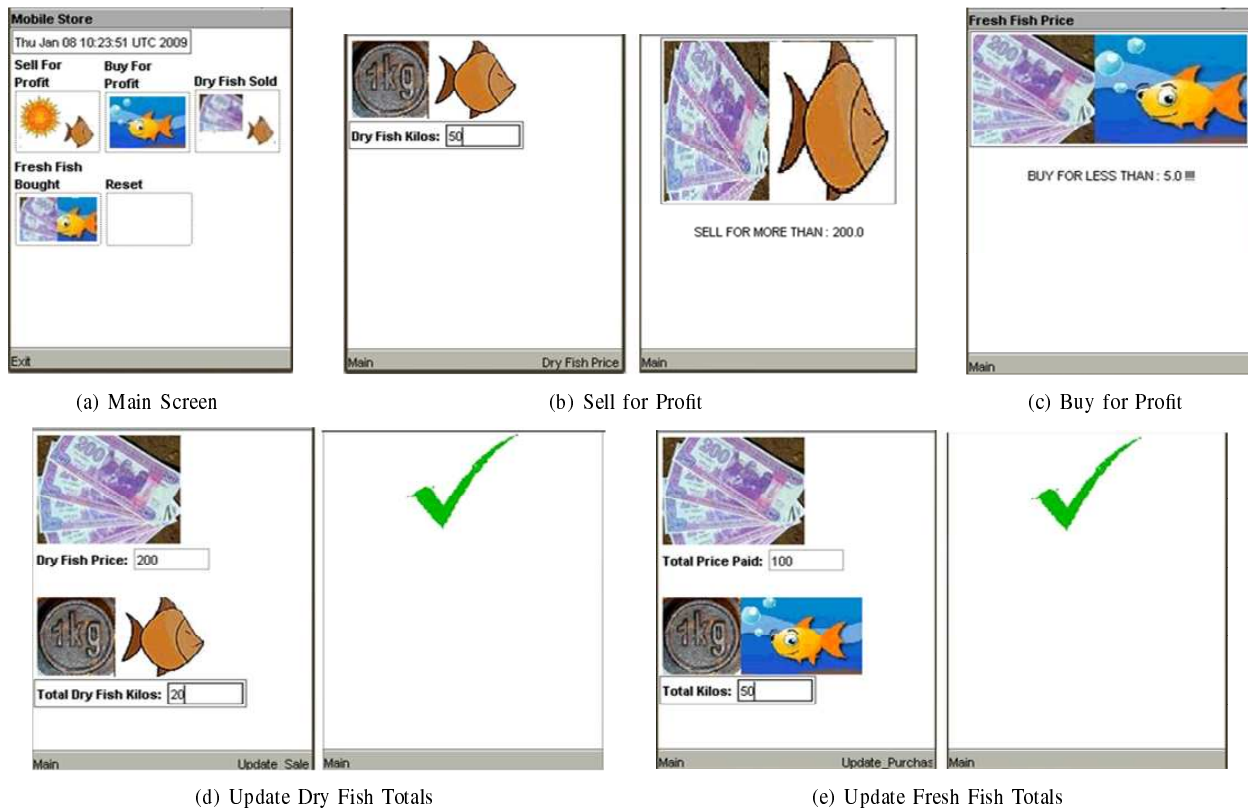


Fig. 3. Screenshots of Buy and Sell for Profit fisherwoman applications.

is successfully updated the screen shown on Figure 3(d), right, is displayed.

Whenever the fisherwoman buys a certain amount of fresh fish for a certain price, she must click on the Update Fresh Fish Bought button, and input the kilos of fresh fish bought and the amount paid to buy the fresh fish (Figure 3(e)). Then she should click on update purchase to update the database.

Upon clicking on the Reset button all the previously collected and maintained information is deleted.

2) *Technical Details:* The J2ME application, Buy and Sell for Profit, maintains a database that contains information related to every selling and buying transaction that took place. Whenever the fisherwoman sells dry fish, she adds a new record, containing the sold amount of dry fish and the money obtained, to the database, via clicking on the Update Dry Fish Sold button. Once the program gets this information it recomputes the price with which the remaining dry fish should be sold. Similarly, this information is also going to be used to recompute the maximum fresh fish price to accept from the vendors for a kilo of fresh fish.

Similarly, whenever the fisherwoman buys fresh fish, she updates the database by clicking on the Update Fresh Fish Bought button and by putting in this new information. Again, this information will be used to recompute both the minimum selling price and maximum buying price with simple algebra.

The Reset button is used to clear the database of all the data that is maintained so far. Unlike the update Dry Fish Sold,

Update Fresh Fish Bought and Reset options, (which modify the database), the Sell for Profit and Buy for Profit options cause the program to just read the data that is stored in the database, and perform some simple calculations in order to display the appropriate minimum selling and maximum buying price, respectively. Moreover, during these calculations, the program also uses the information that on average 2 kilos of fresh fish is transformed to 1 kilo of dry fish.

In order for the Buy for Profit option to work, the program maintains the last 30 sales transactions of dry fish, and then uses this information to compute the average price paid by the dry fish customers for a kilo of dry fish. Then, with simple calculations the program finds the maximum buying price of fresh fish, so that the fisherwomen will have profit. Moreover, since we only keep record of the most recent sales transactions of dry fish, we rule out the case where the maximum buying price is computed using old and outdated data.

The application was implemented using the Eclipse framework [16], [17] for J2ME [18]. The database is maintained using the RecordStore class which comes with the javax.microedition.rms package [15]. Hence, even when the application exits the data that is stored in the database is preserved, and when the application is restarted again, the information previously stored can still be used.

3) *Lessons Learnt:* On the return trip to Senegal, the application was brought to the fisherwomen by a native Senegalese speaker. What was discovered was that the fisherwomen

actually do not have any bargaining power over the fresh fish prices or the dry fish prices. They are forced to buy and sell the fish with fixed prices. Given this new information which we were not aware at the time of conception it deemed the application not applicable in this case. However, the same type of fish businesses is also present in other parts of the world, for example Bangladesh, where bargaining is common in this business. We can use the same application in these areas, but with images of that area's currency rather than Senegalese Currency (CFA).

Moreover, there are other small informal businesses in Senegal where the people have bargaining power over prices, and generally speaking they have the same business cycle of buying raw products, transforming them and then selling the produced product. For example, there are small businesses where the women buy fresh fruits/fresh vegetables, put them in jars with preservatives and then sell the preserved fruits and vegetables. The fisherwomen application can easily be changed to be used by such businesses by replacing the images and the conversion factor for the goods. Thus by changing only variables and images in our Buy and Sell for Profit application, we can make it work for other similar informal businesses.

This application is useful for similar type of businesses where the prices are not fixed, but the fact that the application could not be used by the fisherwomen reiterates the notion that any applications designed for developing and informal economies must be supported by locals and people (our co-workers) on the ground in the communities. Assumptions made by designers on the outsides may be contradictory or incorrect.

### III. EDUCATIONAL DICTIONARY APPLICATION

ADD main goal is to prepare children from age 3-7 from the poorest areas to enter French school systems and be able to stay there. ADD is located in the house of its president with a pre-school is located nearby. In the house of the president they created a Library for children (books are donated by people in France), a space for children from the neighborhood to study and be successful at school, a Cyber cafe with two computers with internet connection. The pre-school has 3 sections for children between 3 and 7 years old with total around 110 children. Children speak Wolof at home and on the streets with no exposure to French. When they go to state school (all schools are only in French) they have to learn French, reading and writing, arithmetic all at the same time and as a result a dropout rate is enormous. It is typical for all of the country. Only 12% of the Senegal population finishes High School (French baccalaureate). ADD also helps children through all of their school years. They also promote neighborhood support and activities, organize Summer camps, and often provide just a quiet place for children to come and read, and draw and study. Based on the knowledge we obtained, we decided to develop a simple and entertaining mobile-based French Dictionary to aid the children to learn basic French vocabulary while playing.

One on the main motivations for creating the dictionary application was to foster improved education. One major issue in developing countries is the lack of resources and a cultural perspective of education as secondary to earning a living to support the family. Also, in many places the retention of children in schooling past the early years is low, which we believe is mainly due to the fact that many countries have different spoken and official languages. As a result the literacy rates tend to be low. The dictionary application was envisioned to bring a simple and entertaining tool to your children to help to aid in their vocabulary learning and increase literacy. By implementing the application on the mobile phones the goal was to reach out to all children and even adults through technology which is already present.

Due to the fact that the literacy rates are low, the application is designed to teach through images, sound, and text. Many of the spoken languages are not written languages, and therefore the use of sound clips to speak the dictionary words is used to convey the vocabulary. Additionally, the interface was designed to be simple and self-explanatory in order to remove any dependance on language. Pictorial representation of application functions were used. Since, the application is aimed at diverse age groups, a short textual description of the dictionary word is also selectable as an option. We focused our dictionary database on nouns and verbs which are used in daily life.

#### A. Application Functionality

The dictionary application consists of a grid of images displayed in randomized order. Each image represents an noun in the dictionary. The user operate the dictionary in the following way. On the home screen as in Figure 4(a), there are two buttons: about and enter. The about button displays information about the application. The enter button leads to the next screen. The user also has an option of exiting the application from the home screen. The user selects an image of his/her choice from the picture grid as in Figure 4(b).

On choosing the image, the size of the image increases and the image is displayed in larger form on the screen as in Figure 4(c). The name of the object appears on the screen (word in English spelling). The pronunciation of the word can be listened to by selecting the play button/option. On clicking the Details button, the description of the object whose picture is selected is displayed in a few words as in Figure 4(d). Through this description, the user can gain information about the object rather than just learning its pronunciation and spelling. The goal of this was to help the user to form a better understanding of the word in their memory. This application requires assistance as the description of the word is written in English and may seem complicated to the user group aged 10-12 years. This screen also has a Home option of returning to the home screen and a 'more' option for displaying other words in a random manner to the user.



Fig. 4. Screenshots of the dictionary application.

### B. Technical Details & Challenges

The main goal of the Dictionary program was to teach education through enjoyment. To express this goal we focused on making the interface access friendly, easy to use, and visual appealing. To implement the interface the dictionary application uses kuix, a j2me hierarchical framework which uses xml and css [19]. Kuix works well for both extendability and UI design.

Two main technical issues cloud the implementation of the dictionary application. The first issue is the database and storage scheme implemented to store all the dictionary words. There are several factors which influence these decisions: How many words/pictures are required? How large are each of the pictures? How should we manage/organize the images; Do the phones have enough memory support in the RMI or in the mobile SD card? To properly answer these questions, we need to determine the specific characteristics of the application users. Age group, education level and language play a major role. For example, it is not required to teach the entire Webster Dictionary to a 12 year old. A few hundred fundamental words would be decent.

Memory should be accounted for the audio files which store the pronunciation of words. One of the main challenges we faced using J2ME is the upper limit on the size of a 1MB jar file. In order to address this issue we used a jar-structured division strategy to implement along with SD cards and an interface called “external file loader”. We use this loader to serialize and uniform all image or audio data for all words in the dictionary.

Another issue raised during development was the trade-off between the resolution of images used and speed of the application. For example, when a static picture sized 10KB is used a S40 Nokia takes 5 sec to browse 10 pictures. However, for XXX it takes XXX. Repercussions of using a larger dataset or/and animated pictures also must be taken into consideration. A possible solution could be using the external file loader, or a hashtable structure proposed to speed up the paging of different jar files and the mapping of images/audios in different jar files.

### IV. CHALLENGES

They were different sets of challenges we faced while developing ideas, principles and user interfaces for both types of applications: the financial and the educational dictionary.

The main challenge in both financial applications was to invent a set of simple, universal and comprehensible images representing the functions which were to be performed. The first challenge in the goal-oriented accounting application was how to represent the abstract notions such as income, outcome, total income, savings, savings goals, minimum balance to be kept in a store, categories of products sold, and categories of external and internal expenses as naturally comprehensible and immediately recognizable icons. As we began development of the application for a specific place and country we have first used in our prototype the symbols connected with Senegal. Only later, through further development did we work to make the application, and hence the images, as much universal as possible. The images presented here result in many discussions, changes in content as well is in shape and color. If they seem obvious and simple it means that we have achieved our goal.

The buy and sell for profit application is still close to our first prototype whose primary goal was to assist Senegalese fisherwomen. The future challenge is to make it as universal, as the first application has become.

In the dictionary application, making a choice of interpretable and useful pictures was difficult and subject to personal opinion. Various factors such as intercultural differences and regional diversity also influenced the choices. Since the application is deployed on mobiles as jar files, the storage limitations implied using very small resolution images. Therefore color rich, intense and high resolution images could not be included. Further development of the application would include using an external memory card is used to store images.

Overall, for all the applications, the main difficulty was the selecting images which convey the proper concept for the function in the application. Determining how another culture or user would interpret the meaning of a picture or symbol is a difficult task. As a results we found that throughout the

development of the application it is of crucial importance to have people in the communities who speak the native language and understand the culture assisting and interacting with the users.

## V. CONCLUSION

In this work we presented three mobile phone applications that were inspired by the needs of the women connected with the Women Business Center (WBC) located in Saint Louis, Senegal. Two of the applications focus on addressing the financial aspects of the businesses and the third was aimed at education. The applications presented here strive to provide intuitive and illustrative interfaces in order accommodate users from all levels of society and educational and national background. We also presented the operation and implementation details of each applications and discussed the challenges and lessons learned throughout the process.

## VI. ACKNOWLEDGMENTS

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