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MOBILE COMMERCE MODEL TAKING ADVANTAGE OF A NEAR FIELD COMMUNICATION (NFC)

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ABSTRACT

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This paper presents an alternative method of shopping using NFC which aims to be easy, user-friendly, and more convenient. In this system, the supermarket or mall with an existing electronic shopping system will incorporate the NFC technology. The application would be used by the customer to scan the NFC tags attached to the products in the store. All the items to be purchased will be listed on the application, customers can make the necessary adjustment to the quantity they want to purchase and can proceed to make payment using their ATM card details before proceeding to checkout. In traditional shopping spaces, people need to carry baskets all over the shopping mall, get the products they need and add them to their baskets. All the products in your baskets will be billed at the exit counter. This process creates a long queue for checkouts and payments at the exit counter. The overall shopping process takes up a lot of time and more manpower is needed to manage the large crowds. The application is developed using JavaScript as the programming language and Extensible Markup Language which enables us to build an application with a rich user interface, with the Integrated Development Environment platform as Android Studio. The project was implemented on an NFC enabled Samsung NOTE 3 device, 4gb ram, 32gb internal phone storage, Android 7.0.

Contribution/Originality: This study contributes to the existing literature in that it establishes a model for M-Commerce that can be used to solve problems faced during online transactions.

1. INTRODUCTION

As far back as the late 1990s, many have enjoyed a comfortable lifestyle due to mobile devices. Wireless networks were developed in Africa by the early 2000s. Currently, in many developed countries, the penetration level of mobile devices is around 80-90% [1]. Mobile devices that are enabled by wireless network growth have spread all over the world. Electronic business applications have become the most popular application for mobile device users who want to make business transactions easily and securely, anytime and anywhere. In the typical retail areas, people want to bring around carts all over the shopping mall and get the items they need and add them to their shopping carts. All the items in your carts are then paid at the exit counter. There is a long queue at the

exit counter for checkouts and transactions. In the traditional shopping spaces, people want to bring around baskets all over the shopping mall and get the products they need and add them to their baskets. All the products in your basket are then billed at the exit counter. So there's a long queue for checkouts and payments at the exit counter. The extra retail cost takes a lot of time and therefore requires additional workers at the counter to handle large crowds. This overhead can be reduced simply by adding a user-friendly M-commerce system based on Android.

1.1. Mobile Commerce and Near Field Communication

Mobile commerce is the purchasing and sale of goods or services by wireless devices such as mobile phones, personal data assistants (PDAs), smartphones and other handheld devices. Mobile commerce is also known as any monetary value that takes place through mobile telecommunications networks. Mobile business is about using wireless eCommerce to conduct internet business using mobile devices. It can also be defined as the exchange value or the use of mobile devices to purchase and sell financial products, services or information online. Near Field Communication (NFC) is a two-device contactless communication technology. NFC is based on RFID technology and ISO/IEC 18092 is standardized. It is restricted to a distance of up to 10 cm between the two devices. NFC's goal is to make transactions easier and more convenient, share digital content, and connect electronic devices with a touch. NFC operates at 13.56 MHz and was jointly developed by NXP Semiconductors (formerly Philips Semiconductors) and Sony Corporation. Since NFC can read and write to phones, in the future they are expected to be used more commonly than regular smart cards. NFC requires a goal and an initiator. The initiator initiates and actively generates an RF signal based on the name, initiates and tracks data exchange (a payment device) where a passive target (a smartphone) responds to the request. Active is where both the initiator and the target communicate through their electrical fields generation. In half-duplex, they do this; deactivate their RF field until no other device is transmitted. Typically, both devices will have power supplies in this mode. Passive mode will be the more common application where the initiator is the only device generating an RF signal, the target device will respond to the call by modulating the existing field that the initiator device listens for and then processes the data transmission. Currently supported data rates are 106, 212, 424 or 848 Kbit/s.

1.2. Why Mobile Commerce and Near Field Communication?

The quality of life activities in our society is immensely developing as a result of available technologies. The customer has to actually pick up the items to be bought in a typical shopping process and carry cash or credit / debit cards with them and wait in a long queue to make payments. Near Field Communication (NFC), a wireless data transmission interconnection system that operates in close range. Combined with electronic devices, NFC has become an inherent mode for two NFC devices allowing information to be exchanged in close proximity. NFC technology is thriving due to its flexibility among other wireless technologies. Traditional shopping system takes a lot of time as customers have to wait in a long queue for the payment process at the cash counter, this takes a lot of time and energy of both the cashier and customer. The traditional systems require modifications in its business methods for ease of use for customers. With this motive in mind, a system needs to be developed which provides the customer an easy to use interface and provides the merchant with a means of boosting more products. The process can be simplified by bringing up a user-friendly, hassle-free M-commerce system using NFC technology. NFC technology is a remarkable technology for use in the mobile payment system, and its features can be harnessed for an automated shopping system.

2. RELATED WORKS

Madhuri, et al. [2] developed a shopping application system which uses contactless NFC tag technology for purchase of all products at shopping malls. The time required for purchasing and billing will be minimized since the user can make a purchase directly from his android NFC enabled mobile device. The application gathers customer's

information during installation, after subsequent purchase, the customer's information is sent to the database for security purpose. This is also helpful for QR generation. The shopping mall server connected to an NFC terminal helps with the addition update of information and generates QR code for products. Then the android mobile phone is used to scan QR code, view item details, add or delete items. An e-payment system is used for payment methods. The system's ultimate aim is consumers' convenience and time efficiency. However, it was not without its limitation, the approach is limited as its focus is majorly on users who frequently visit the mall.

Jay, et al. [3] developed an automation system based on the NFC shop. The proposed system was designed to replace the bulky smartphone shopping cart. Similar products will have an NFC tag with all the product information in the shopping center. The model also has a billing system where customers scan their smartphone and transfer the billing product details. It is also possible to make payment through an existing payment process. However, it was not without its limitation; the design is limited because the overall model is expensive to implement in a very large supermarket with different products.

In Andres, et al. [4] an application of NFC in medicine that helps in patient diagnosis is proposed. The developed system has the ability to generate magnetic field with low frequency via the reader and this gives the system upper hand over Bluetooth based systems because it takes care of the biological tissues that cannot absorb low-frequency magnetic field. The whole idea is that a low-frequency magnetic field is generated by the analog front end when some values of voltages are induced in the LC circuit and the voltage used is always rectified. However, it was not without its limitations, which were; the biological tissues cannot absorb low-frequency magnetic fields and the cost of building a system like this is quite expensive.

Adithkiran and Jagadeesh [5] Proposed a new approach to use NFC technology to protect health care monitoring systems. Mobile is now more convenient and available to virtually every common man. Such critical instruments are used in the medical sector for our advantages. A simple tap is all you need to tell you to check your records or your entire medical history and what's wrong. The advantages of this technology will be that it will allow patients with minimal effort to be properly and accurately diagnosed from time to time. As in an emergency procedure, for instance, the doctor must begin all the tests from scratch and conduct his examination and administer the drug accordingly. By using this software, however, we should make sure that the records are kept in a proper database and are easily accessible as NFC only requires a tap. However, it was not without its limitations, which were; the cost of building a system like this and making it readily available is expensive.

Adam, et al. [6] gives a new idea on how to provide medical facilities in a low-resource world through NFC. For a lot of people, the missing price of mobile phones makes it affordable. The main goal is to incorporate a concept that can mostly be used in developing countries. The example used here is the Karachi healthcare system where pneumonia is diagnosed in children using this theory. This approach has major drawbacks as it is not reliable in terms of identifying patients and detecting diseases. It was introduced by developing a mobile with a patient presence alert system based on the NFC principle and the enrolled patients will have an NFC card that the doctor can scan. Then the doctor would be advised to conduct the pneumonia test, if this turns out to be positive then the records of the patient would be sent out for further examination and care. The idea is introduced using mobile phones as it provides an added advantage of Bluetooth's facility. It was not without its drawback, for example, when there is problem with the cell phone, there is no way data recovery can be done because it cannot be backed up.

Borkar, et al. [7] designed a secure application for shopping mall using NFC. The proposed model was based on NFC which includes QR code (Quick Response Code) to develop a secure application in the mall using NFC. The system creates wireless payment for shopping malls. The payment is free of credit/debit cards, harsh cash. In this model, AES (Advanced Encryption Standard) a symmetric block cipher is used for providing security for the user's bank details. The model is limited by its rigid payment system as it creates wireless payment for shopping malls. The system is also free of credit/debit cards.

Nurbek, et al. [8] highlights NFC's position in the Independent and Full ACMS (Access Control and Management Systems) and the management of student attendance and location within the institute. The main modules are created by many sub-modules: server application software, NFC reader, controller, and framework for smartphones. The system comprises two main parts, the registration and door lock /unlock phases. There are two different data exchanges to be carried out in these two previously mentioned phases. The exchange of information is divided into two sub-phases. The server initiates the first sub-phase. The controller starts the second sub-phase where it is waiting until the system is in the missing proximity. The main advantage of this is that a smartphone does not need to switch the button whenever it gets lost, the lost device's UID can be simple. Therefore, it provides great convenience and is easy to consider for end-users. However, all students at the institute cannot use an NFC-enabled telephone because they are quite costly.

Lawrence and Kibua [9] submit an idea promising to be the future mobile money service of Kenya using NFC technology. We claim that phone-based phones can be turned into mobile payment systems. Various forms of payment solutions are used throughout the world. The main objective was to research the viability of common and primary mobile network modes including SMS-based transactions, mobile billing, wireless online payments, and NFC's more promising prospects in the future. The mobile companies started building their NFC-equipped mobile phones.

For big players in the ICT and the telecommunications industry, NFC technology has come into focus. The software will generate cash for a mobile wallet. This will allow Kenya's users to easily conduct certain transactions without any harm. However, the survey says more than half of Kenya's population is using smartphones. We illustrate the NFC's range by using the transport sector because of its high population figures. No system was implemented to ascertain if there were limitations to it.

Jhe-Yi, et al. [10] present the premise that mobile e-commerce based on android can satisfy the required safety and serviceability standards. In the approach outlined, the smartphone is activated by the design center around providing a counter reader and a payment client on an android. The three (3) authentication factor approach combines encryption of PIN code, USIM card authentication, and facial recognition via biometric procedures. Three-factor authentications are both effective and secure for the transactions to take place in a low-risk environment. Biometric identification is the most important and crucial aspect of this technology and the built-in camera has become almost a must in a cell phone, expensive and inexpensive, so it is easy to achieve the objective of facial recognition. The program was limited as there was no thorough investigation into functionality.

The aim of Tripathi and Ojha [11] is to reduce the cost and time of creating public-key service and mobile payment registration processes. The authors suggested a process comprising three stakeholders: the consumer, seller, and issuer. The customer exchanges messages with the issuer through the retailer to fulfill honesty and other aspects of mobile transactions. Once the customer has purchased an item, the customer sends a message through the retailer to the issuer in exchange for which the customer receives a confirmation message through a successful transaction's payment gateway. The payment gateway, when verifying the transaction for the customer, also sends a message to the seller that the correct amount has been sent to the customer's account. The aim of this proposed method is to simplify mobile payment procedures for low-end mobile phone owners who cannot afford other resource-demanding methods such as NFC and RFID transactions. One of the popular issue, however, is security.

3. SYSTEM ANALYSIS AND DESIGN

Architectural design represents the structure of data and program components that are required to build the system. It considers the architectural style that the system will take, the structure and properties of the components that constitute the system and the interrelationship that occur among all architectural components of a system. There are various architectural patterns; in this case, the repository architecture will be used.

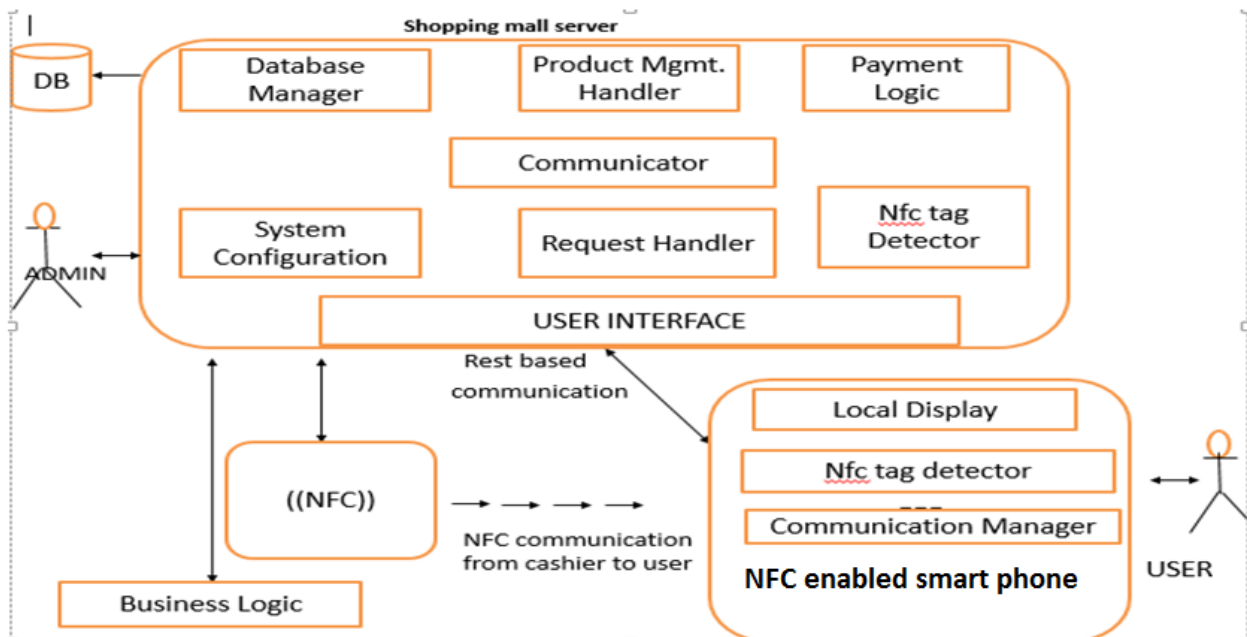


Figure-1. NFC-based mobile commerce system architecture.

The architecture of the system will mainly consist of;

1. Shopping Mail Server: The administrator will have access to this server. The Admin will be able to perform this activity like; Add/Update product information, Data Validation, Generate NFC tag ID for products.

The shopping mall server comprises the following components:

User Interface: A rich graphical user interface will be there to operation consistently.

Payment Logic: The appropriate payment method is selected, would be done with debit cards.

Product Management Handler: This module manages different products, like checking stacks, when users delete some products from his/her cart.

Request Handler: There will different types of request like login and authentication, adding/deleting products, request for payment.

Communication Manager: Communication will act as a communication module.

NFC tag Detector: Generally every product has its own NFC tag. There will be an NFC tag ID generator that will generate an ID for each product.

System Configuration: It will contain the configuration files required for the system.

Database Manager: A database manager is essential to perform various operations on database.

2. NFC enabled Android-based mobile phone: The user i.e.; the customer will have an NFC enabled smartphone which will be NFC enabled. This is the second main component of the system.

The user can perform operations like, scan NFC tag, Add/Delete products, and view product details. The user mobile phone will be used to detect the NFC tag attached to products.

NFC tag detector: To detect the NFC tag attached to products.

Local Display: This will display the products contained in the carts, adding/deleting the facility.

Communication Manager: it will manage the communication between the mobile phone and the shopping mall server.

A mathematical model proposed for the system is defined below:

Let R – Represents the registration module, that is (Admin and Customers) respectively.

α – Represents list of customers scanned products to be purchased.

β – Represents list of customers scanned products billing details.

ρ – Represents payment service for checkout module.

i.e. R takes two forms; R_c which is complete registration and R_o which is incomplete registration

Registration module needs to be completed before one can proceed to the next module.

so if $R = R_c$ then customers can proceed to the next module

$$M = f(R) \circ f(\beta) \circ f(\rho) \tag{1}$$

Where

$$\alpha = (\alpha_{(i)}) \quad i = 1, \dots, n. \tag{2}$$

$\alpha_{(i)}$ – list of customers scanned products to be purchased.

n – is defined as the of list of items selected (scanned) by the customers.

$$\beta = (\beta_{(i)}, \alpha_{(\beta_i)}) \tag{3}$$

$\beta_{(i)}$ – Customers chosen products billing details which must be items in the list of scanned products in α

i.e. $\alpha (\beta_{(i)}): \alpha \rightarrow \beta$ – maps set α to set β

$$\beta \supset \alpha \tag{4}$$

$$\rho = \sum_{i=1}^n \beta_i \tag{5}$$

ρ – Sum of bills of items chosen by the customer before checkout.

$$M = f(R) \circ f(\beta) \circ f(\rho) \tag{6}$$

So, M is a composition of the functions for the registration module, billing and payment module respectively.

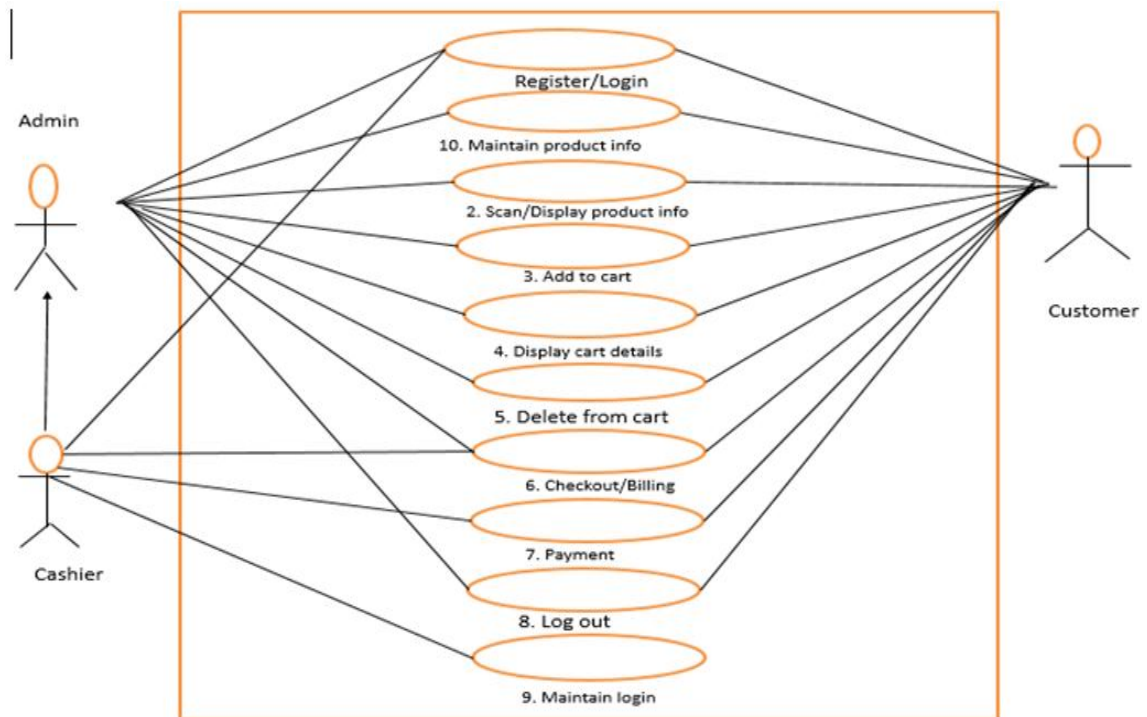


Figure-2. The use case diagram of the system.

Register: A customer is mandated to register if the user wants to gain access to the system.

Login: After registering, the customer logs in with their email/passwords but wouldn't have access to the basic functionality of the application until the admin approves the customer's login details so has to avoid theft and validate the customer's information before granting access to the application.

Scan/Display Product Info: The user will be able to scan products and the details of the products will be displayed.

Add To Cart: The user can add items to cart after successfully scanning products they want to purchase.

Delete from Cart: The user can also delete the product from the shopping list as the case may be.

Checkout/Billing: After the user successfully adds all products to the shopping list, the product billing details would be displayed.

Payment: This deals with the payment method on the platform.

Maintain Product Info; The Admin is charged with the responsibility of maintaining product information.

4. SYSTEMS IMPLEMENTATION AND RESULTS

Mobile commerce model that uses NFC technology provides a number of functionalities ranging from making the shopping process hassle free to generally making the shopping process less time consuming. Data transfer in this system is done by scanning NFC tags using NFC enabled devices. It attempts to eliminate as many inconsistencies as possible from the traditional commerce system and provide more convenient and user friendly shopping experience to the customer. The user interface is such that the users would have a wonderful user experience tailored particularly for them. The administrators would also be given power to be able to approve new users who signed up to the system and also add products and their details. The user interface is divided into two, the administrator and the customer interface. The interface of the administrator is completely different from the interface of the customer.

Below are some screenshots of what the system looks like.

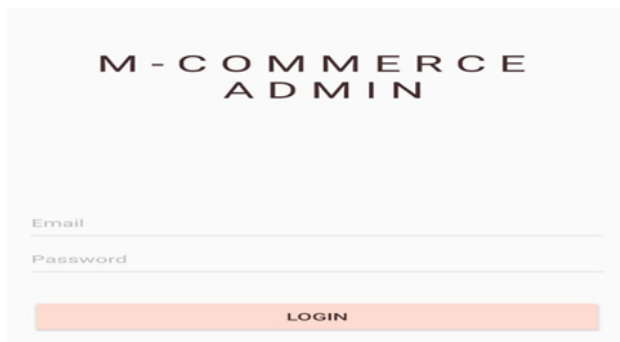


Figure-3. Login page of the admin.



Figure-4. Scan tag for product page for the admin.

This login page in Figure 3 above is for the admin to log into the system in order to be able to perform some set of functionality on the system. Some of this functions are stated below.

In Figure 4 the admin is responsible for scanning tags attached to product so has to add it into the system in order for user to be able to access it as soon as they login to start the shopping experience.

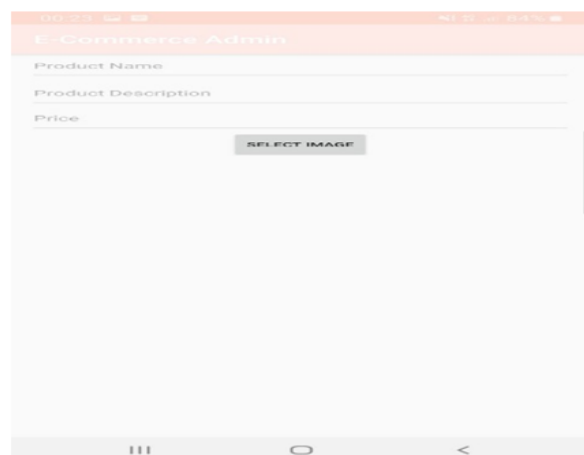


Figure-5. Page to add product information by admin.

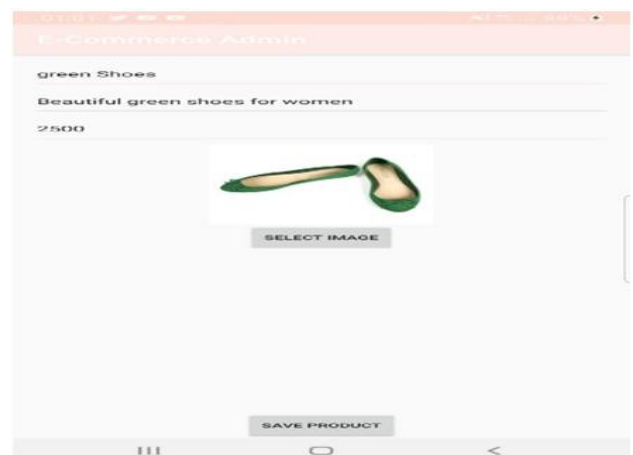


Figure-6. Save product information by admin.

From Figure 5 the admin is charged with adding the product information, such as the product name, product description, price and the image. In Figure 6 above, the product information is saved.



Figure-7. Register page for the user.

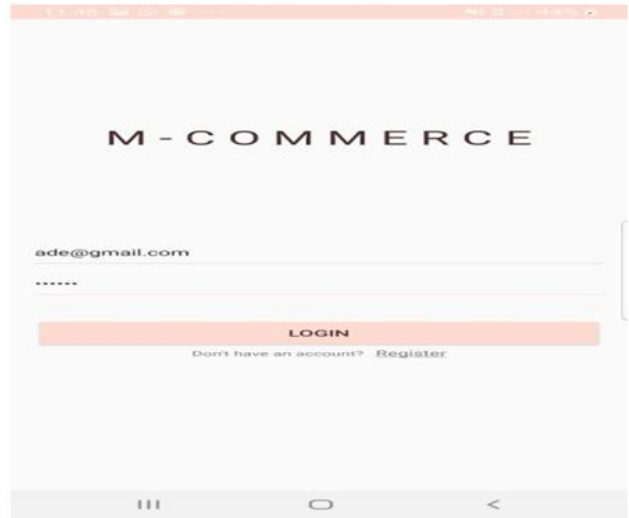


Figure-8. Login page for the user.

Upon initiating the application, a signup page is prompted [as shown in Figure 7 above]. The existing users of the application provide their emails and passwords and access is granted after the Admin has approved the user account details, this is to keep record of all users and authentication [as shown in Figure 10] New users are required to sign up [create an account on the application] as shown in Figure 8 Afterwards, the user logs into application with the account details [email address and password] already registered.

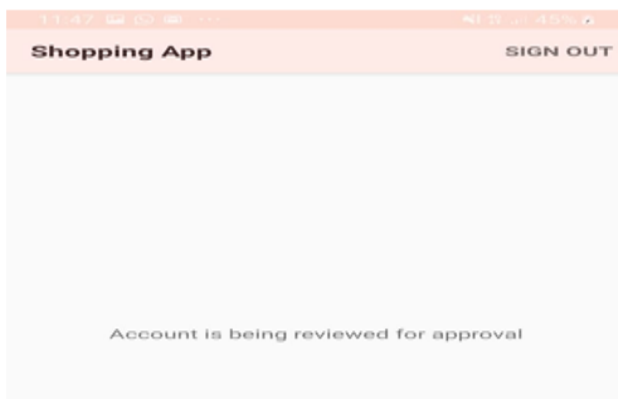


Figure-9. User account waiting for approval.

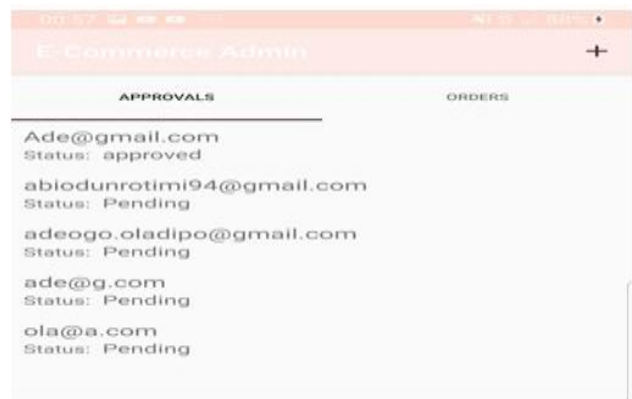


Figure-10. Admin approval page.

After logging into the application, the first page that is prompted is empty a shopping list [as shown in Figure 11] because no products have been added yet. To purchase products, user has to tap or scan the tags on the products to be purchased and add them, the details of the product will be displayed, it also shows the price [as shown in Figure 12 & Figure13 below] The user can scan as many products as possible to add to the shopping list.

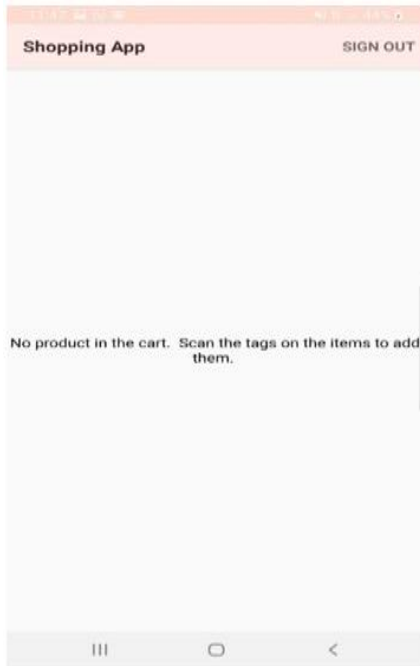


Figure-11. Welcome page.

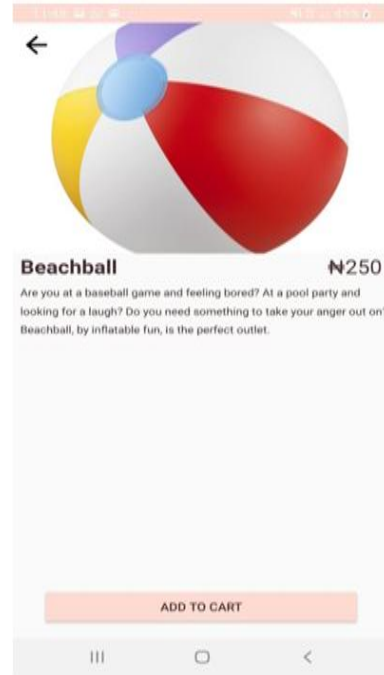


Figure-12. Scanned Product.



Figure-13. Scanned Product.

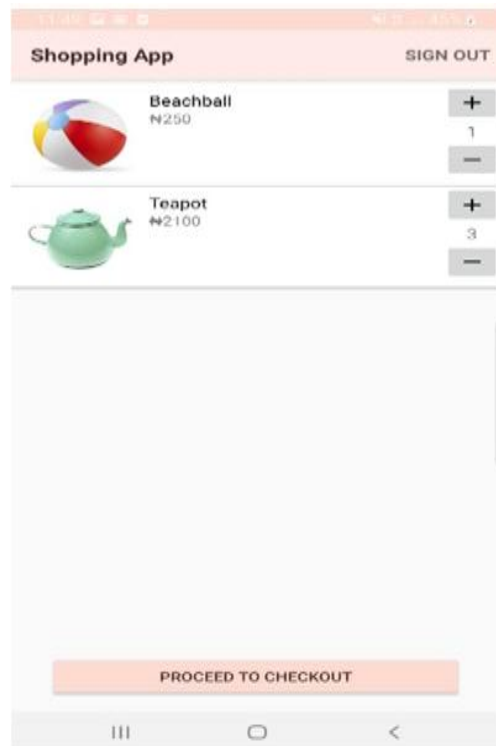


Figure-14. Shopping List.

The shopping list shows the items to be purchased by a user, it also shows the price of the products, the user will enter the unit of the products and it can be edited by clicking the plus icon beside the name of the products as shown in Figure 14. Products can be deleted from the shopping list by clicking the minus icon under the plus icon as also shown in Figure 14.

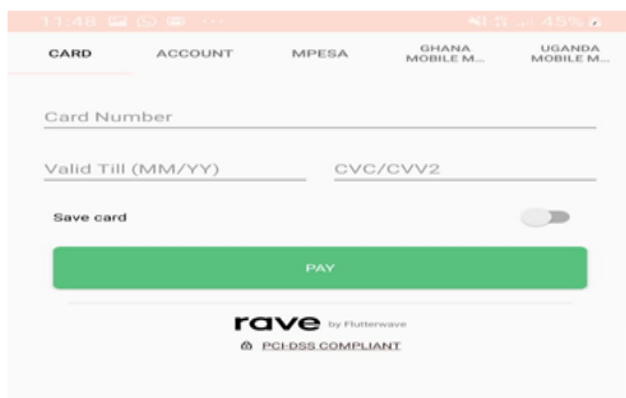


Figure-15. Payment Process.

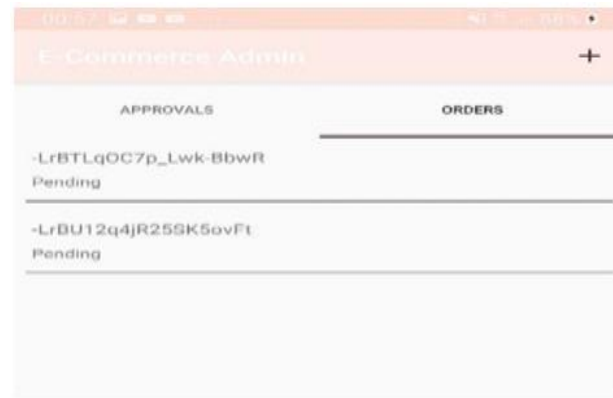


Figure-16. Orders from User.

The user can view the list of all products with price that have been added to the shopping list, by proceeding to check out the products billing details would be displayed which will be items of scanned products in the shopping list in Figure 14 above. The user will make payment using their ATM card details for the payment process [as shown in Figure 15 above] and order would be received at the admin section, then products will be delivered manually before checkout.

5. CONCLUSION

The system is created with ease of understanding and the design is tailored towards making the shopping experience easier, with the friendly user interface it will be convenient for users to do the entire shopping process without wasting much time and no more standing in queues and waiting for the turn. Near Field Communication has the advantage that makes it possible to perform communication without exposing important secrets of personal information including financial transaction data, as important NFC technology is, there is low number of NFC enabled mobile phones and it is mostly limited by cost, thereby discouraging small and mid-sized companies from adopting the technology and there remains much to do in terms of development and improvement of the on the system.

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