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DEVELOPING AND ANALYSING M-WALLET FOR BUSINESSES IN GHANA

Masters' Thesis in Communication and Systems Engineering

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ABSTRACT

Internet availability in African countries has been immense benefit in the technological world. Accessibility of internet is common in Ghana as all the telecommunication networks provide internet services to their customers. Ghanaians can connect their laptops and other devices to their hotspot from their phone or use an internet modem to access the internet or browse directly from their phones.

This has created opportunities for other business ventures which include the possibility of having m-wallet to carry electronic business transactions. The need to provide a better easily accessible m-wallet for electronic transactions (Savings and Payment of bills electronically) called for this thesis topic.

This thesis focuses on the implementation and analysis of the m-wallet for businesses in Ghana. The analysis is done with the case study of Kuulchat, a popular educational social network in Ghana for students to socialize and sell to other students and Pre-vas Motors, a company for selling brand new and old cars.

The benefits, challenges and success factors of the developed application for the main targeted groups (Students for the case study with Kuulchat and the E-commerce businesses) is also analyzed. Both the mobile and web application is designed, implemented and tested. Android studio is used to develop the mobile application and notepad++ using CSS, JavaScript, PHP programming language and Mysql database to develop the web application.

The user top up his m-wallet either through a scratch card or by MTN Mobile Money. This m-wallet is used to deposit & transfer money and make online payments.

KEYWORDS: M-Wallet (Mobile Wallet), Mobile Money, Mobile App, Web Application, Fund Raising, Mobile Wallet in Ghana

1. INTRODUCTION

Internet availability in African countries has been immense benefit in the technological world. Accessibility of internet is common in Ghana as all the telecommunication networks provide internet services to their customers. About 19.6 % (5,171,993 out of the 26,327,649) of the population uses the internet. Ghanaians can connect their laptops and other devices to their hotspot from their phone or use an internet modem to access the internet or browse directly from their phones.

This has created opportunities for other business ventures which include the possibility of having m-wallet to carry electronic business transactions. The need to provide a better easily accessible m-wallet for electronic transactions (Savings and Payment of bills electronically) called for this thesis topic. The m-wallet designed and implemented would be referred in this thesis as **KuulPay**.

Electronic banking is the execution of financial services via the Internet (Martin Schuring : 2014). This has reduced costs and increased convenience for the customer. Customer can be at anywhere and can carry on banking transaction such as sending cash to love ones.

The ever-increasing spread of Internet-enabled phones and personal digital assistants (PDA) made the transformation of banking applications to mobile devices a logical development of internet banking (Martin Schuring). According to Martin Schuring, the sweeping enthusiasm that characterized much of the news reporting in the years 1999 and 2000 mobile banking should by now have been firmly established as the most important distribution and communication channel for retail banking but this is not the case today.

It is not too long ago that developing countries like Ghana started to introduce mobile banking into the system. The mobile banking become very popular when the telecommunication networked ventured into such business.

1.1. Background

The most common use of ATM, Debit or credit cards in Ghana are for withdrawals and physical paying of goods and services. Ghanaians hardly use these cards for online payment.

A number of Ghanaians own a Visa card but hardly use it for online payments hence the need to create a portal that can allow Ghanaians to make payment online using their mobile money wallets. A number of banks in Ghana have electronic banking system that enables their customers to mainly access their accounts and transact business (Make Payments).

This electronic banking is mainly used by the few who have some knowledge in ICT. Many still visit the bank premises to withdraw physical cash instead of using Visa cards. Many of the banks with the electronic banking system don't have the possibility to make purchase online and use their electronic banking system for payment. It is mainly limited to the day to day transaction within the company. Only few electronic banking systems have the possibility to transfer money from one bank to the other.

The electronic banking especially the mobile banking became very popular when MTN Mobile money by MTN was introduced to the system as the first telecommunication company to offer mobile banking to its subscribers. This mobile wallet enable customers to deposit physical cash into their electronic wallet and withdraw at a merchant point at small charges. The merchant who does the deposit or withdrawal is given a commission. This commissions attracted many individual businesses to apply for a merchant sim to make transactions on behalf of MTN Mobile Money, making the patronage very high and welcoming.

Other telecommunication companies saw how booming the mobile banking was and decided to join the market to compete with MTN Mobile Money. Other mobile money provided by other telecommunications include:

- Voda Cash by Vodafone
- Tigo Cash by Tigo

- Airtel Money by Airtel

Due to the mobile banking, many Ghanaians stopped or reduced the frequency of visits to the banking premises. Most Ghanaians use the mobile wallet as their sole banking system because of its easy accessibility. Thus most of the mobile money merchants are closed to them and can access money from the m-wallet at any time or day (Most Mobile Money Merchants work till late hours and even on Sundays).

1.2. Problem Definition

Many Ghanaians do not possess a visa and so cannot make online purchases. The most common used payment portal is the mobile money which doesn't currently have a simple integration to applications to enable online payment. One needs to have a programming knowledge to implement it and the process involved is long and tiresome. It is therefore necessary to have a portal that will provide the payment gateway with a few line of codes that a lay man could easily integrate into his web or mobile application.

Currently, there is no platform to mobilize funds for personal or community developmental projects in Ghana. This also called for the need to add this feature to the KuulPay design and implementation so people can easily create a project and others can use their KuulPay account to make contributions.

1.3. Purpose Statement

The purpose of this thesis is:

- To analyze the electronic banking in Ghana
- To analyze some existing M-wallets and their state of the art solutions

- To design m-wallet for electronic transactions
- To implement the design into existing platform (kuulchat.com)
- To analyze the finished product

1.4. Research Questions

This thesis project would be focused on the above mentioned problems and would be guided by the questions below:

A. How can an electronic wallet which is simple and easy to integrate into other platforms be developed for developing countries?
B. What impacts will such m-wallet make on people?

1.5. Focus and Limitation

The focus of this thesis is to design and implement m-wallet that is simple and easy to integrate into other existing platforms. The application would be designed, developed and tested.

The limitation of the application is the necessity to have internet access before the application can be used either on the website or the mobile app.

1.6. Thesis Structure

The chapter one gives a general overview of the online payment situation in Ghana and the need for this thesis. The chapter provides the objectives and research questions for the thesis.

It also throws light on the importance of this thesis. The chapter also defines the limitation of the thesis implementation. Chapter two considers researches made similar to this topic and describes the design phase of the KuulPay application. Describes the already existing mobile wallets in Ghana and why the need for this thesis. Furthermore, it describes the design of both the mobile and web application.

Chapter three gives more information about the implementation of the thesis work. It discusses the environment and technologies used in the implementation process.

Chapter four discusses the integration of the developed application into an already existing platforms (Kuulchat) and a new online shop (Pre-vas Motors) to enable online payments and also the fund raising feature of the application is also tested in this chapter.

Chapter five summarizes the outcome of the m-wallet, the launching of KuulPay and future research topics.

2. LITERATURE REVIEW AND APPLICATION DESIGN

2.1. Literature Review

Painuly and Rathi (2016:357) in their research paper "*Mobile wallet :An upcoming mode of business transaction*" defined Mobile Wallet as a payment services operated under financial regulation and are performed from or via a mobile device. With this service, a person may not wish to use the ongoing ways of payments like cash, cheque or debit/credit cards. Rather, step on to speedy digital method of transactions through mobile phone through its associated applications.

The number of mobile phones in use far exceeds any other technical devices that could be used to market, sell, produce, or deliver products and services to consumers. These developments open lucrative opportunities to merchants and service providers. Dahlberg, Mallat, Ondrus and Zmijewska (2007:1).

Japan is thus far the only country to have successfully adopted a mobile payment system with millions of active users. Amoroso, D. L., and Magnier-W, R (2012:95)

Mobile devices can be used in a variety of payment scenarios such as payment of digital content, tickets, parking fees, transportation fares or payment of bills and invoices. Hundreds of mobile payment services, including access to electronic payments and internet banking, were introduced all over the world. Many of these efforts failed. Dahlberg et al. (2007:2).

In developed economies, consumers and merchants have numerous different payment instruments and solutions from which to choose. Over the years, they have developed well-established routines and preferences that are hard to change. Harry B.,Mark de R., Andrea C., Jeremy L., Swati M., Maud V.T. Dahlberg(2015:2). This is not the case in developing countries such as Ghana. Most transactions are done by cash until the recent

initiatives by the telecommunication companies to introduce mobile payments on their platform. This creates more opportunity in the m-wallet business in the Ghanaian market especially online payments.

In order to develop a better successful mobile wallet, it is important to learn what previous studies have discovered about mobile payment service markets and reasons why some of them were not successful.

In Dahlberg et al. (2007:10), it was stated that in order to develop and launch a mobile payment services that will be adopted by consumers, it is crucial to understand user adoption factors. Dahlberg et al.(2007:11) identified cost and "usefulness" as important adoption factors for consumers. In order for the mobile payment to be useful to the consumer, it is then necessary to involve the consumer during the development of the new mobile payment system. This can contribute to the success of the mobile payment system since it will be useful to the consumers and will solve a problem that might be faced by the consumers.

Mobile payment services have failed to entice consumers. An apparent conclusion is that these services have failed to meet consumers' payment needs. Deeper understanding of consumer adoption motivations is thus needed to be able to develop and launch mobile payment services successfully. Dahlberg T. and Öörni A. (2007:1)

The consumers will also compare the new mobile payment to existing payment methods such as cash, cheque, credit or debit cards or other existing mobile payments and so it is necessary it is less expensive than the existing ones in order to convince consumers to switch to the new mobile payment system. Merchants create the market for financial institutions and other mobile payment service providers by accepting payments with mobile payment instruments or even issuing them. Their active participation in promoting a payment service is crucial to consolidate a large number of points of acceptance. Dahlberg et al. (2007:11).

It is therefore important to be considerate in the transaction charges for the merchant and the payment system needs to be easy to use and fast as they are already busy business people. Other incentives could also be given them to attract them to use the mobile payment system to increase the consumers of the payment system.

Balan, Ramasubhu and Tayi (2006:3) in their research paper "*Digital wallet: Requirement and challenges*" have identified about Singapore's use of digital wallet and analysed the key challenges in building and deploying a digital wallet. In their research, one of the challenges is designing a mobile wallet that consumers want to use. They stated that the Mobile Wallet application must be a usable interface and support for all financial transactions that a user may want to perform. They also stated in their research that supporting cash transactions require two key technology components.

1. A mechanism for placing cash in the mobile wallet
2. Mechanism for transferring that cash to a retailer or another digital wallet.

Rathore (2016: 69-73) in her research paper "*Adoption of Digital wallet by consumers*" analysed the factors that influence consumers in adopting to digital wallet and the risk and challenges faced by consumers in the usage of the Mobile Wallet. She concluded that Mobile Wallets are quickly becoming mainstream mode of online payment and shops are largely adopting Mobile Wallets at an incredible rapid pace because of the convenience and ease of use. It is also a hassle free mode of making online payment and this is the most adored feature of a Mobile Wallet.

She also stated in her research that security and safety of the funds is the most challenging issue for the users. Another challenge she stated in her research was the dependency of Mobile Wallet on internet connection to make payment. This has been one of the major reasons for less adoption of the Mobile Wallet.

In her research paper, she made some few recommendation for encouraging Mobile Wallet usage. Some of her listed recommendations include:

- Marketing and promoting the mobile application to create awareness among non-users
- Educate the consumers about the benefits of a digital wallet in simplifying and streamlining their purchasing experience.

Gannamaneni, Ondrus and Lyytinen (2015:1159) in their research "*A Post-Failure Analysis of Mobile Payment Platforms*" shared more light on why some mobile payment platforms failed. Numerous firms saw the commercial potential in operating mobile payment platforms, Mobile Network Operators (MNOs) also saw the potential of generating additional revenue by enriching their portfolio of value-added services and increasing stickiness of their customers. The financial institutions also saw the potential of mobile payments to increase the use of electronic transactions for which they could charge a commission. Gannamaneni et al. (2015:1159).

The growing number of failed initiatives for mobile payments raised concerns for the future of mobile payments as researchers has declared that mobile payments could be the next killer application for mobile commerce. Gannamaneni et al. (2015:1159). Despite the emergence of Near Field Communication (NFC) which was proven to be effective for mobile payments, most mobile payments initiatives have failed. Gannamaneni et al. (2015:1159).

Mobile payments have been adopted in developing countries to compensate for the lack of other payment instruments such as credit cards. Many who possess visa or credit cards in developing country such as Ghana mostly use it to withdraw cash from their bank account at the ATM machines. Only few use it to make purchases at a counter or online.

Depending on the mobile payment architecture, mobile payment platforms can involve (or not) actors such as Mobile Network Operators (MNOs), banks, financial institutions, payment networks, payment service providers, technology providers, mobile handset manufacturers, payment terminal manufacturers and other third parties. Gannamaneni et

al. (2015:1161). In Gannamaneni et al.(2015:1161), the different actors involved in a platform were classified into three distinct levels of actors thus, sponsor level, platform level and user level.

In KuulPay case, the sponsor level encompasses the roles involving platform sponsors such as MNOs (MTN Mobile Money). The platform level includes the different points of contact of the users with the KuulPay platform such as the technology solution of the KuulPay payment system. The user level includes the merchants and consumers.

In Gannamaneni et al. (2015:1162), the paper stated that Paybox, a mobile payment platform in Germany owned by Deutsche Bank failed because they could not attract funding due to the lack of cooperation from other potential partners in the mobile and financial service industries. The potential partners saw Deutsche Bank as a competitor and were deterred by its substantial stake in Paybox. Paybox failed to offer significant advantage in order for merchants and customers to abandon existing payment schemes which was working quite well. The technology was also not cost effective for consumers since it involved SMS and voice base communication which added costs as compared to traditional payment schemes. Gannamaneni et al.(2015:1162) also stated that Paybox failed to link credit cards to their system and that was also one of the reasons of their failure. Gannamaneni et al (2015:1166) summarized the reasons of failure of the mobile payment platforms in a table as shown below:

Table 1. Gannamaneni et al (2015:1166) reasons of failure of some mobile wallets

	PA	M0	P0	M1	M2	M3
Sponsor						
Malfunctioning collaboration	X	X	X	X		X
No win-win business model	X	X	X	X	X	X
Lack of support & promotion	X				X	
Platform						
Inadequate technology & standard			X	X	X	
User						
Low value compared to existing solutions	X	X	X	X	X	X

PA = Paybox; M0 = Mobipay; P0= PostFinance; M1,2,3= Moneta

From the above table, one could see that all the above mobile payment systems failed to add value to their payment system so consumers could switch to or maintain (if already using) their system. The consumers find no reason to quite using their existing solutions. This means that it is necessary for KuulPay to add value to already existing payment systems in Ghana in order to succeed.

Lack of cooperation at the sponsor level was also the reason why all failed. This means it is important to have a win-win solution with the merchants and other financial or Mobile Network Operator that KuulPay needs to fully implement the system. Thus KuulPay, the merchants, the MNOs and the users should all fully benefit from the KuulPay payment system in order for the system to be fully accepted and succeed.

In Mas, I., and Rotman, S.(2008:12), it is stated that Mobipay did not have a marketing budget to promote its own service and has a result Mobipay has languished in the absence of effective marketing or a “killer application” that can raise public awareness of the service.

It is therefore necessary for KuulPay to create the awareness of the payment platform for more people to patronize it and use the service in order to sustain its continuous existence.

The most used MNO for the mobile money transaction is MTN Mobile money and so, KuulPay has partnered with MTN Mobile money to include their payment system on the KuulPay platform so that non-KuulPay users can also perform financial transactions on KuulPay with their MTN Mobile money account. MTN will be charging for every transaction carried on their platform. KuulPay will therefore add something little to their charges so the merchants bear the cost (MTN Charges + KuulPay Charges[Very small]) if non-KuulPay users decide to use the MTN Mobile money payment to make payment on the KuulPay platform. This is very important so that KuulPay could have large consumers who use the KuulPay platform.

In the second version, KuulPay will consider adding the possibility to choose to make payment with debit/credit card on the KuulPay platform. This is also very necessary to increase the consumers of the payment system. This will entice fund raisers who wish to have people from outside Ghana to make donation to their project via KuulPay.

Hypothetically, the greater the perception that mobile wallet does not require much mutual efforts to use, the more likely consumers will exert a positive attitude towards mobile wallets. This implies that if the payment system is easy to use or learn, consumers will perceive the method as useful and will more likely accept the technology. Tan, Ooi, Chong and Hew (2014:295).

2.2. Use Cases and Targeted Users

The targeted users are mainly students and businesses that need online payment portal. Most of the students especially the university students have access to smart phones and the internet and are more familiar with information technology than the older ones. Students could use the platform to purchase items on the Kuulchat social network and also receive money from their parents through the KuulPay platform. The second targets are the merchants who are into the e-commerce business and the paying of bills by parents in schools.

Use Case Scenario 1

A student on campus wants to buy an item (Textbook, Laptop, Phone etc) posted on Kuulchat social network. The person must make payment of the item before picking it up at a Kuulchat office located on campus.

Use Case Scenario 2

A parent wants to send some cash to her child on campus. The parent should be able to send the cash through KuulPay to the child on campus. The child should also be able to withdraw the physical cash once the money is sent to him.

Use Case Scenario 3

A student wants to print out his final year examination (B.E.C.E or W.A.S.S.C.E) result to use for something very important but it is weekend or it was past 5:00pm and so the post office that sells the W.A.E.C login pin is closed. The student should be able to buy the pin online and pay with KuulPay. The pin details should be sent to his phone once payment is confirmed.

Use Case Scenario 4

A customer visits a website that sells at affordable price. He considers the stress he would go through in traffic and the cost that is involve in going there by himself and the item being brought to his door step or a closest pick up point. The E-commerce site should be able to have a KuulPay online payment to accept payment from MTN Mobile Money | KuulPay users.

Use Case Scenario 5

A person or a group of people want to raise some funds for a personal or community project. The person or the group should be able to use KuulPay to raise the funds.

2.3. Considering The State of the art solutions of other M-wallets

Multifactor Authentication (2FA)

Two Factor Authentication is an extra layer security used on a number of M-wallets such as Wibmo. This requires not only a password and username but also something that only, and only, that user has on them, i.e a piece of information only they should know or have immediately to hand such as a physical token.
Using a username and a password together with a piece of information that only the user knows makes it harder for potential intruders to gain access and make transaction especially making payment with one's account.

KuulPay will use this extra security in addition to the username and password when making payment. KuulPay will generate a token and send to the user's phone number that was used during the sign up. The user will then use the sent token to confirm his payment. An unauthorized person does not have the phone at his disposal and so won't be able to confirm the transaction. Once 3 failed attempts is reached, the user's account will be blocked and the person logged out. The rightful owner must then contact KuulPay to reactivate the account after being asked a number of security questions. Once the user is able to confirm ownership of the account, KuulPay will activate the account and encourage the person to change his password.

Contactless Payments

Apple and Android Pay use this technology to enable customers complete purchases by using their NFC (Near Field Communication) which is compatible with apple or android devices. The transaction is finalized using one's finger print or personal password. This technology would be considered in the second version of the application.

From the above literature review and the state of the art solutions mentioned above, in order to design the KuulPay application, the customer requirements must be considered since they are the ones who would be using the mobile wallet application.
This requirements can be grouped into:

1. Technical Requirements
2. Usability Requirements
3. Design
4. Security

Technical Requirements

The usage must be possible with all kinds of available mobile devices. It should be possible for the user to use his preferred device, in order to benefit from its advantages.

The application should adopt to the conditions of the device automatically. It should detect the kind of device the customer is using and adapt automatically to its features.

The amount of the transmitted data should be as small as possible as mobile data transmission is expensive and waiting time would be high when the transmitted data is large. If the application consumes lots of data, the customers may be reluctant to use the application since they would be paying both the data and the charges for using the KuulPay services.

Usability Requirements

It is important to access quick information such as account balance with just a few 'click' or if possible with just one click. It should also be possible to work offline with the application but this is the limitation of mobile wallet and KuulPay as well. Internet connection is necessary to access the service and record transactions on the server.

In the second version of the application, KuulPay would contact some of the telecommunication networks to provide a USSD code which KuulPay users can use to make simple transactions such as loading cash to the wallet and transferring cash to others. This would make it possible to work offline on the mobile phone with short USSD codes provided by the telecommunication network.

Design Requirements

There should be a possibility to get announcements on important events. If possible either as SMS or push notification. There should be a wide range of functionalities similar to the one they enjoy in the physical bank and this should be easy to navigate.

Security Requirements

The transmission of the data has to be encrypted because of the sensitive data. The access to the data must also be authorized, thus user has to prove he is entitle to have access to the mobile wallet account. Authorization has to be fast and simple for quick access of the data.

2.4. Functional and Non Functional Requirements

A functional requirement describes what a software system should do while a non-functional requirement place constraints on how the system will do so.
Below are the functional requirements of the KuulPay Mobile Wallet:

1. The application should let a user deposit cash into his mobile wallet
2. The application should let a user withdraw physical cash from his mobile wallet
3. The application should let a user check his account balance
4. The application should let a user transfer money to another person (Whether a KuulPay user or a non user)

5. The application should let a user raise funds for a project
6. The application should be possible to integrate into other e-commerce website to enable KuulPay users or Non Users to make online payment through the application

Modelling The Non Functional Requirements in UML

The non functional requirements are modelled using the above functional requirement and the UML diagrams shown below:

Depositing Cash Into Wallet

Funds can be deposited either through a scratch card or by MTN Mobile Money. The scratch card will be sold at merchant shops. The amount of cash will be indicated on the scratch card so user buys the amount he wishes to deposit into his account. One who already uses MTN Mobile Money can also top up his KuulPay account through MTN Mobile Money. The depositor of the cash bears the charges of the MTN Mobile Money. Thus the total cost for depositing into wallet from MTN Mobile Money is equal to the amount depositing plus the MTN Mobile Money charges.

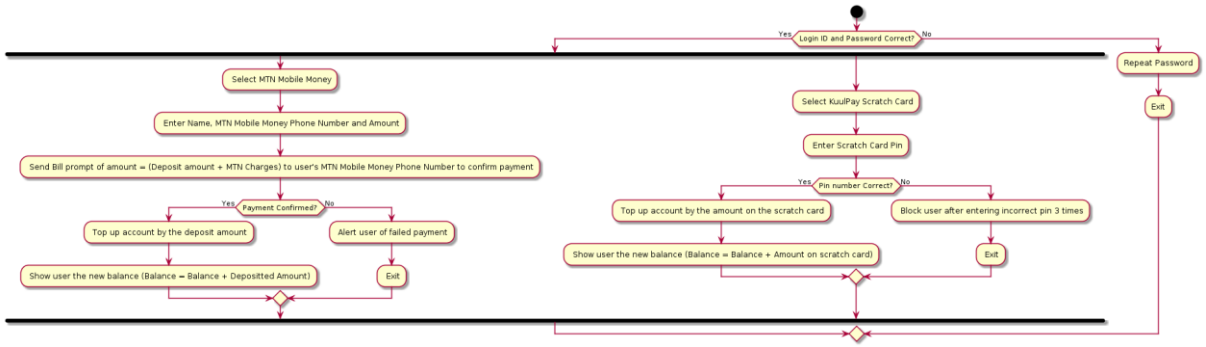

Figure 1. Depositing cash into wallet by either KuulPay Scratch Card or MTN Mobile Money

Withdrawing Physical Cash From Wallet

The only option for withdrawing physical cash from the wallet at the moment is through a merchant. The KuulPay user generates a token which he takes to a merchant for withdrawals. This same token can be generated by a KuulPay user for a Non KuulPay user to use to withdraw physical cash.

Generating A Token For Payment

The KuulPay user fills in the token generating form which is basically the amount to withdrawal and the security question and answer to the security question. The security question and answer together with the token ID are used to authenticate the token to ensure that the one withdrawing the cash has the right to do so.

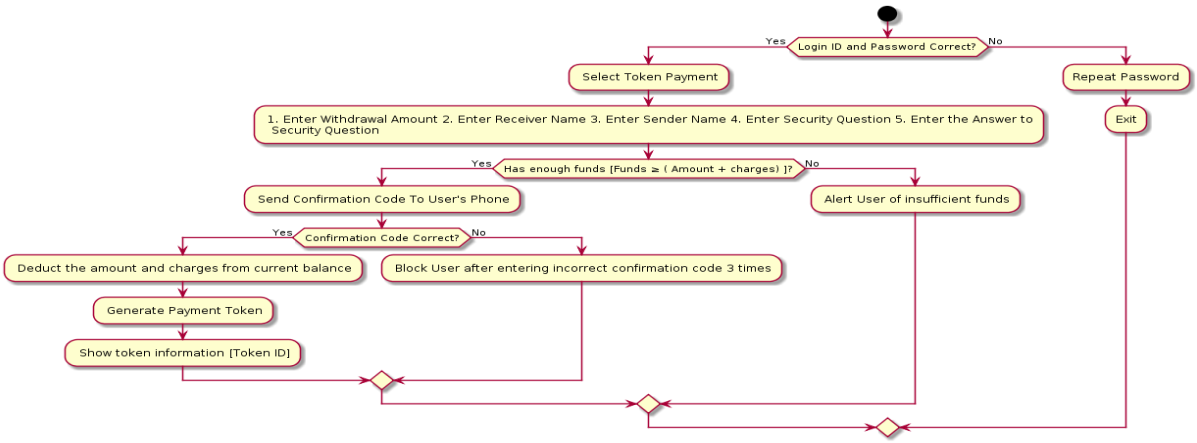

Figure 2. Generating A Token for Withdrawing cash from wallet

Withdrawing Cash At A Merchant Point

The merchant receives the token generated by a KuulPay user and validates to see if is correct before carrying on with the withdrawal. The token is charged when generated so one don't pay at the merchant point. Once the withdrawal is made, the merchant gets his commission of the amount charged on the token.

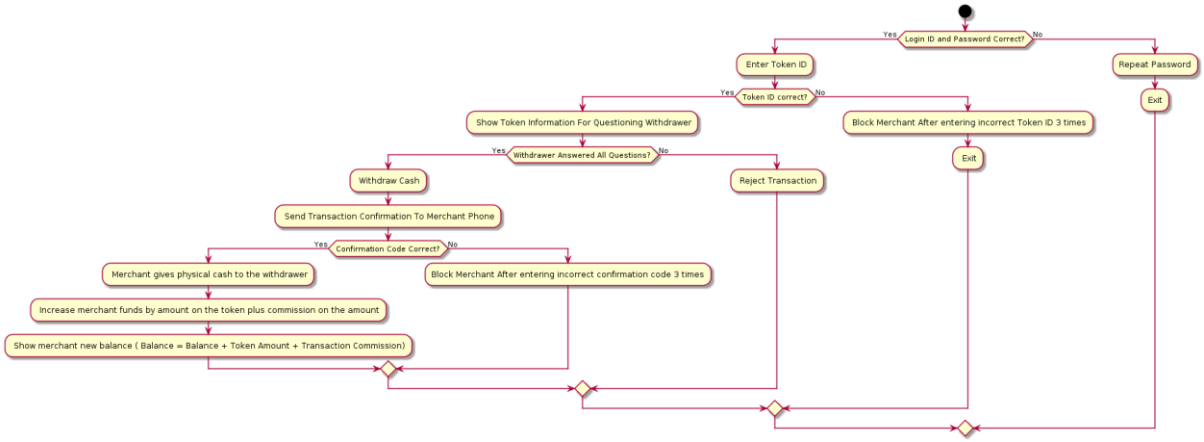

Figure 3. Withdrawing cash at a merchant point

Transferring Funds To A KuulPay User

A KuulPay user can transfer cash from his wallet to another KuulPay user's wallet. This is done at no cost. The unique identifier of the recipient is his phone number and so the amount and the phone number of the recipient is entered and once confirmed, the cash is transferred.

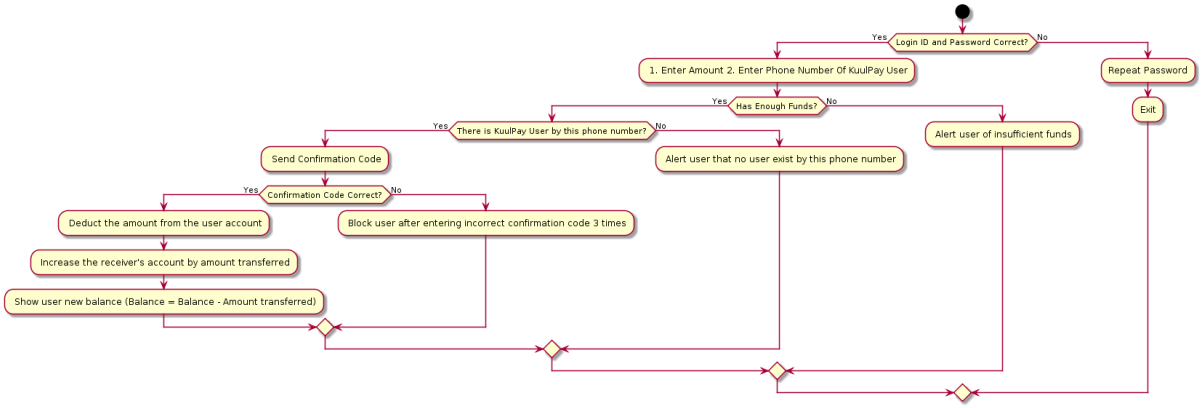

Figure 4. Transferring funds to a KuulPay user

Online Payment With KuulPay

A merchant embeds a script on his website which enables him to receive payment via KuulPay. Once a 'Pay with MTN Mobile Money | KuulPay' button is clicked on the merchant website, the buyer is directed to KuulPay to make the payment. Once payment is confirmed or cancelled, the buyer is redirected to the merchant's website.

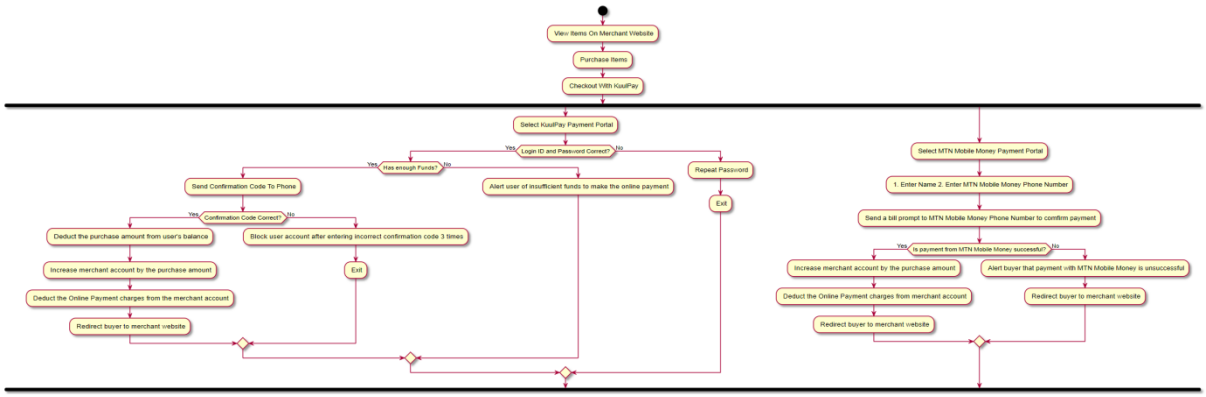

Figure 5. Online payment with KuulPay System

Show KuulPay User's Account Balance

It is suppose to be very easy to check balance of wallet. This is very important because the user may wish to quickly know about the current status of his mobile wallet account in order to make decision whether to purchase something or not. The showing of balance should therefore be very quick and easy.

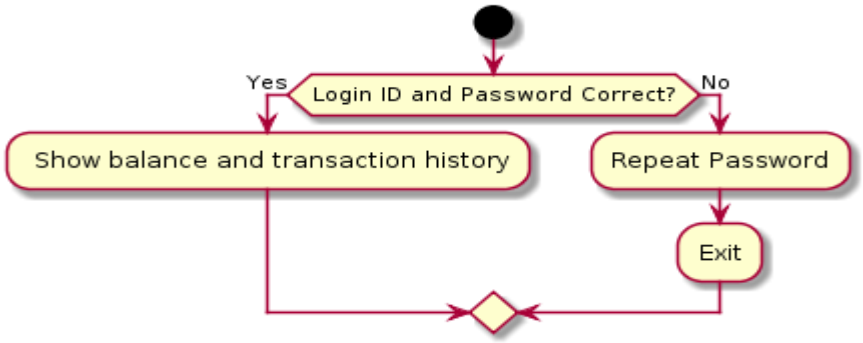

Figure 6. Show balance on wallet

Creating A Project To Raise Funds

A KuulPay user creates the project and either makes it public so that everyone can see it on the KuulPay website to make contributions or makes it private so that only few he gives the details to can make contribution to the project.

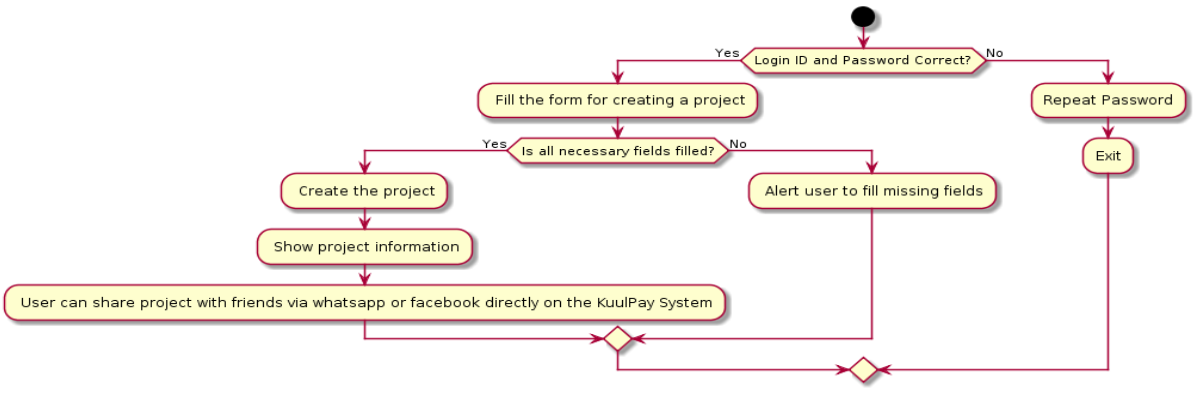

Figure 7. Creating a project for fundraising

3. SOFTWARE IMPLEMENTATION

The KuulPay M-wallet can be accessed on the phone either by KuulPay app installed or web browser to the url:kuulpay.com. Even though KuulPay is a M-wallet, the web application is implement to be responsive to the device accessing the pages in order for people who are browsing on their laptop to also enjoy using the platform.

The software implementation would therefore be grouped into two. The Mobile Android implementation and the web application implementation. This is to enable everyone to have access to the M-Wallet. Those who don't have an android phone to install the app or low memory on phone to install the app can therefore use the web application since browser is available on all phones or computers and can therefore be accessed anywhere by any device.

3.1. The Mobile App

The mobile app is developed in android using Java programming language and android studio. Java is a general-purpose computer programming language that is concurrent, class-based, object-oriented, and designed to have as few implementation dependencies as possible. This programming language is developed by Sun Microsystems which is now owned by Oracle corporation.

Android Software Development is the process by which new applications are created for devices running the Android operating system. The applications are usually developed in Java programming language. Android was developed by Google and released on October, 2009.

Android studio is one of the tools used for programming android applications.
The application communicates with the server through a PHP web service (Script)
PHP (recursive acronym for PHP: Hypertext Preprocessor) is a server-side scripting language designed mainly for web development and can be embedded into HTML.

What distinguishes PHP from client-side JavaScript is that the code is executed on the server, generating HTML which is then sent to the client. The client would receive the results of running the script but would not know what the underlying code was.

3.1.1. Interface Implementation

The android mobile app interface is designed with an xml resource file located in the layout folder. Thus res/layout/filename. An example is shown below with the KuulPay home interface (Login Interface)

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    android:background="@color/white"
    android:padding="10dp"
    >

    <ScrollView
        android:id="@+id/login_form"
        android:layout_width="match_parent"
        android:layout_height="match_parent">
        <RelativeLayout
xmlns:android="http://schemas.android.com/apk/res/android"
            android:layout_width="match_parent"
            android:layout_height="match_parent"
            android:orientation="vertical"
            android:background="@color/white"
```

```
android:padding="10dp"
>
<ImageView
    android:layout_width="300dp"
    android:layout_height="50dp"
    android:layout_marginBottom="20dp"
    android:src="@drawable/logo"
    android:layout_alignParentLeft="true"
    android:layout_marginRight="40dp"
    />
<TextView
    android:id="@+id/registerTxt"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="Register"
    android:layout_marginTop="5dp"
    android:layout_alignParentRight="true"
    android:textColor="@color/colorPrimary"
    android:textStyle="bold"
    android:textSize="20dp"
    />
<TextView
    android:id="@+id/loginLabel"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="LOGIN"
    android:textSize="25dp"
    android:layout_marginTop="40dp"
    android:textColor="@color/colorPrimary"
    android:textStyle="bold"
    android:layout_below="@id/registerTxt"
    android:gravity="center"
```

```
                />
            <LinearLayout
                android:id="@+id/loginArea"
                android:layout_width="match_parent"
                android:layout_height="wrap_content"
                android:orientation="vertical"
                android:padding="10px"
                android:layout_below="@id/loginLabel"
                android:layout_marginTop="20dp"
                android:focusableInTouchMode="true"
                >

<android.support.design.widget.TextInputLayout
                    android:layout_width="match_parent"
                    android:layout_height="wrap_content">

                    <AutoCompleteTextView
                        android:id="@+id/pin"
                        android:layout_width="match_parent"

android:layout_height="wrap_content"

android:hint="@string/prompt_username"
                        android:inputType="text"
                        android:maxLines="1"
                        android:singleLine="true" />


</android.support.design.widget.TextInputLayout>


<android.support.design.widget.TextInputLayout
```

```
                    android:layout_width="match_parent"
                    android:layout_height="wrap_content">

                    <EditText
                        android:id="@+id/password"
                        android:layout_width="match_parent"

android:layout_height="wrap_content"
                        android:hint="@string/prompt_pass"
                        android:inputType="textPassword"
                        android:maxLines="1"
                        android:singleLine="true" />


</android.support.design.widget.TextInputLayout>
            </LinearLayout>
            <TextView
                android:id="@+id/resetPasswordTxt"
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:text="Reset Password"
                android:layout_marginTop="20dp"
                android:textSize="20dp"
                android:layout_alignParentRight="true"
                android:textColor="@color/colorPrimary"
                android:textStyle="bold"
                android:layout_below="@id/loginArea"
                />
            <Button
                android:id="@+id/login_btn"
                android:layout_width="fill_parent"
                android:layout_height="wrap_content"
```

```
                android:layout_marginTop="40dip"

android:background="@drawable/rounded_button"
                android:padding="10dp"
                android:text="@string/action_sign_in"
                android:textColor="@color/white"
                android:textAllCaps="false"
                android:textSize="15dp"
                android:layout_below="@id/resetPasswordTxt"
                />

        </RelativeLayout>
    </ScrollView>
    <ProgressBar
        android:id="@+id/progressBar"
        style="?android:attr/progressBarStyleLarge"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_centerHorizontal="true"
        android:layout_centerVertical="true"
        android:visibility="gone"
        android:indeterminateDrawable="@drawable/progress"
>
    </ProgressBar>
</RelativeLayout>
```

Explanation of Key Component Of the XML Resource File Above

android:id

This is a unique resource name for the element, which one can be used to obtain a reference to the element in the application.

The ID value syntax is in the form:"@+id/name". The plus syntax,+,indicates that this is a new resource ID and the aap tool will create a new resource integer in the R.java class, if it doesn't already exist. The id value is referred in the Java class. Example:

android:id="@+id/registerTxt"

Is referred in the Java class as:

findViewById(R.id.registerTxt)

android:layout_height

This specifies the height for the element.

android:layout_width

This specifies the width for the element.

It is a must to assign width and height to element and this can be done by:

1. Specifying the exact measurements
2. Either use wrap-content or match_parent

wrap_content: This tells the view to size itself to the dimensions required by its content.

match_parent: This tells the view to become as big as its parent view group will allow.

It is not a good practice to specify a layout width and height using absolute units such as pixels. Instead relative measurements such as density-independent pixel units (dp), wrap_content, or match_parent is better because it helps to ensure that the application will display properly across a variety of device screen sizes.

In order to create views and reference them from the application, the common pattern is to:

1. Define the view/widget in the XML layout file and assign a unique ID

```
<Button
        android:id="@+id/login_btn"
```

```
                android:layout_width="fill_parent"
                android:layout_height="wrap_content"
                android:layout_marginTop="40dip"

android:background="@drawable/rounded_button"
                android:padding="10dp"
                android:text="@string/action_sign_in"
                android:textColor="@color/white"
                android:textAllCaps="false"
                android:textSize="15dp"
                android:layout_below="@id/resetPasswordTxt"
                />
```

2. Then an instance of the view object is created and captured from the layout in the onCreate() method.

Button btn = (Button) findViewById(R.id.***login_btn***);

A click listener is written in the Java activity class to handle the click events. The click listener to the login button in the XML layout above is written as shown below:

```
btn.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        // Reset errors.
        mUsernameView.setError(null);
        mPasswordView.setError(null);

        // Store values at the time of the login attempt.
        String username =
mUsernameView.getText().toString();
        String password =
mPasswordView.getText().toString();
```

```
        boolean cancel = false;
        View focusView = null;
        View pinfocusView = null;
        boolean usernameEmpty = false;
        boolean passwordEmpty = false;
        // Check for a valid password, if the user entered
one.
        if(TextUtils.isEmpty(username)){

mUsernameView.setError(getString(R.string.error_invalid_use
rname));
            pinfocusView = mUsernameView;
            cancel = true;
            usernameEmpty = true;
        }
        if(TextUtils.isEmpty(password)){

mPasswordView.setError(getString(R.string.error_invalid_pas
sword));
            focusView = mPasswordView;
            cancel = true;
            passwordEmpty = true;
        }

        if (cancel) {
            // There was an error; don't attempt login and
focus the first
            // form field with an error.
            if(usernameEmpty){
                pinfocusView.requestFocus();
            }else if(passwordEmpty){
                focusView.requestFocus();
```

```
            }

        } else {
            // Show a progress spinner, and kick off a
background task to
            // perform the user login attempt.
            bar =
(ProgressBar)findViewById(R.id.progressBar);
            bar.setVisibility(View.VISIBLE);
            NetAsync(view);
        }
    }
});
```

The code above validates if the username and password fields are filled. If not it alerts the user. If all fields filled, the progress bar is set visible to alert the user that a process has began and therefore should wait for the response.

The NetAsync(view) method then connects to the server and validates the entered username and password if an account really exist by such details. The server returns a JSON string to the application which processes the information and decide whether to allow user access to the account or not.

JSON stands for **J**ava**S**cript **O**bject **N**otation. Is a lightweight data-interchange format and language independent. At the server side is a PHP script that gets the data passed from the mobile application and checks the field received to see if it matches any user on record. The PHP script then sends the response in JSON string format to the mobile application.

The JSON string from the server is in this format:

{"success":1,"session":"adhdhdhfh20dfhfhfhf","actype":1,"mid":301204}

A **success** value of 1 in the JSON string means that the user's username and password is correct and should be allowed access to the application and a value of 0 means incorrect and access should be denied.

The **session** value in the JSON is stored in the app which is used to identify the user whenever the application communicates with the server. All data accessed from the server is accessed through JSON and the values returned is processed by the application and displayed.

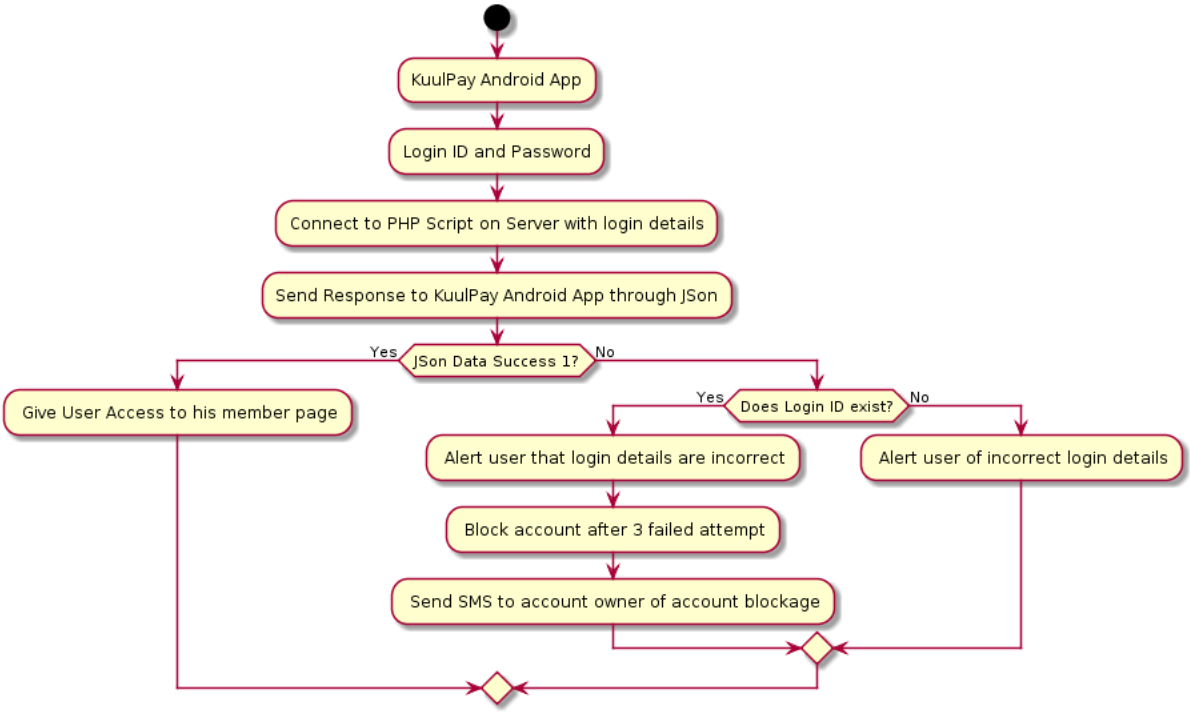

Figure 8. Login Mobile App and Server Communication UML

3.1.2. Security Implementation

Security is very important when it comes to financial application. This is to ensure that people accessing and making any financial transaction in the application has the right to do so. There are four security features implemented on the KuulPay Mobile application to make it more secure for the users.

3.1.2.1. Login Security

In order to prevent unauthorized people from having access to the KuulPay account, a username is used instead of a phone number which is a public information. It is difficult to guess the username of a particular user.

The password that the user also uses is validated during sign up or changing of password to ensure that it is strong enough and difficult to guess. Once there is a failed login for 3 consecutive times, the account is blocked and the user is alerted with a SMS alert to contact KuulPay to reactivate his account and encouraged to change his username if he is not aware of the login attempt on his account.

3.1.2.2. Data Security

The data sent to the server from the application is encrypted and is decrypted at the server for processing. The data sent from the server to the application through JSON is also encrypted and decrypted in the application for processing. This is to prevent people from seeing sensitive data information by analysing the data packet being sent to and fro between the application and the server. This makes it difficult to see the username and the password in plaintext as well as other sensitive information.

The HyperText Transport Protocol Secure (https) used at the server also makes it more secure. The communication protocol in HTTPS is encrypted in both direction (Client

and Server) by Transport Layer Security (TLS) or formerly Secure Sockets Layer (SSL).

HTTPS protects against man-in-the-middle attacks, preventing eavesdropping of the communication. This assures the user that his sensitive data is secured and protected and the website is safe.

3.1.2.3. Authentication Token Security

A code is sent to the KuulPay user's phone for every debit financial transaction to use to confirm the transaction. This is to prevent an unauthorized person from carrying transaction without the knowledge of the owner of the account. It is therefore necessary that the KuulPay user secures his phone since the token is sent to the phone for authentication. If an unauthorized person has access to the phone, he can then use the sent token to authenticate the transaction. It is therefore the responsibility of the KuulPay user to secure the phone to prevent this from happening.

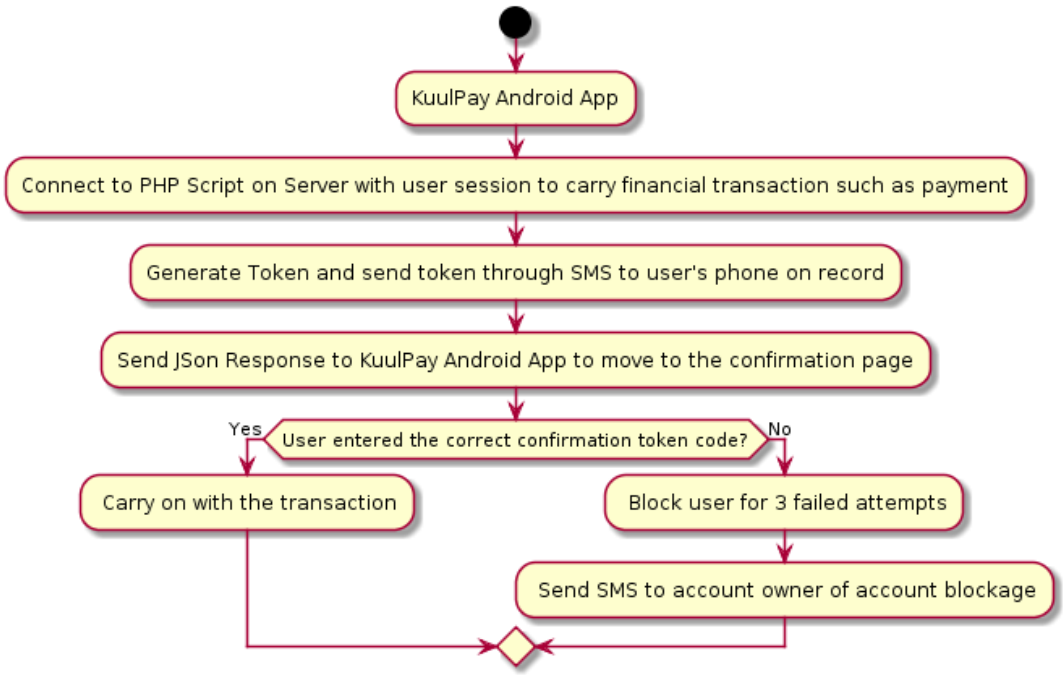

Figure 9. Authentication Token Security UML

3.1.2.4. Idleness Logout Security

The fourth security implementation is logging out users who has been idle. This is to prevent others from having access to account which is already logged into and unattended. The mobile application checks the user's interactions with the application (scrolling, mouse click etc) to detect if the user is idle or not. If user has not interacted with the application for 5 minutes, he is logged out of the application.

3.1.3. Key Functionalities Implementation

```
public JSONObject loginUser(final String username,final
String password) {
    String url = new Config().loginUrl(username, password);
    HttpHandler sh = new HttpHandler();
    // Making a request to url and getting response
    String jsonStr = sh.makeServiceCall(url);
    JSONObject jsonObj = null;
    Log.e(TAG, "Response from url: " + jsonStr);
    if (jsonStr != null) {
        try {
            jsonObj = new JSONObject(jsonStr);
            return jsonObj;
        } catch (final JSONException e) {
            Log.e(TAG, "Json parsing error: " +
e.getMessage());

        }
    }
    return jsonObj;
```

```
}
```

The above function is used to connect to the server to authenticate the user and gets a JSON response . The Config Java class has a function call loginUrl which encrypts the username and password and creates a url where the PHP script for handling the login validation is located. The encrypted username and password is retrieved with $_GET['] in the PHP script for handling login. The username and password is then decrypted and validated from the database if a user exist by such username and password.

Communication between the KuulPay application and the web server is made using Hyper Text Type Protocol (HTTP). The Java HttpHandler() class is used to communicate with the web server and get a JSON response which the function returns and can be further processed. The HttpHandler class is shown below:

```
package com.kuulchatmedia.kuulpay.other;
import android.util.Log;
import java.io.BufferedInputStream;
import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.net.HttpURLConnection;
import java.net.MalformedURLException;
import java.net.ProtocolException;
import java.net.URL;

/**
 * Created by GodwinTawiah on 4/27/2017.
 */

public class HttpHandler {
```

```
    private static final String TAG =
HttpHandler.class.getSimpleName();
    public HttpHandler() {
    }
    public String makeServiceCall(String reqUrl) {
        String response = null;
        try {
            URL url = new URL(reqUrl);
            HttpURLConnection conn = (HttpURLConnection)
url.openConnection();
            conn.setRequestMethod("GET");
            // read the response
            InputStream in = new
BufferedInputStream(conn.getInputStream());
            response = convertStreamToString(in);
        } catch (MalformedURLException e) {
            Log.e(TAG, "MalformedURLException: " +
e.getMessage());
        } catch (ProtocolException e) {
            Log.e(TAG, "ProtocolException: " +
e.getMessage());
        } catch (IOException e) {
            Log.e(TAG, "IOException: " + e.getMessage());
        } catch (Exception e) {
            Log.e(TAG, "Exception: " + e.getMessage());
        }
        return response;
    }

    private String convertStreamToString(InputStream is) {
        BufferedReader reader = new BufferedReader(new
InputStreamReader(is));
```

```
        StringBuilder sb = new StringBuilder();

        String line;
        try {
            while ((line = reader.readLine()) != null) {
                sb.append(line).append('\n');
            }
        } catch (IOException e) {
            e.printStackTrace();
        } finally {
            try {
                is.close();
            } catch (IOException e) {
                e.printStackTrace();
            }
        }

        return sb.toString();
    }
}
```

The above HttpHandler() class has a method call makeServiceCall which takes the URL string and returns the response from the server as a string. Once a JSON string is obtained, each of the data content must be obtained and processed. The code below retrieves each of the data passed in the JSON string.

```
try {
        if(!(json==null)) {
            if (json.getString("success") != null) {
                String res = json.getString("success");
                if (Integer.parseInt(res) == 1) {
                    // Get user data
```

```
                    int actype =
Integer.parseInt(functions.decrypt(json.getString("actype")
));
                    String mid =
functions.decrypt(json.getString("mid"));
                    String sessionToken =
functions.decrypt(json.getString("session"));

                    // Create login session
                    // Delete old entries
                    db.deleteUsers();
                    session.setLogin(true);
                    db.addUser(actype,mid,sessionToken);
                    Toast.makeText(getApplicationContext(),
"Login is successful", Toast.LENGTH_LONG).show();
                    bar.setVisibility(View.GONE);
                    // Redirect to member page
                    Intent intent = new
Intent(getApplicationContext(), MainActivity.class);
                    startActivity(intent);
                    finish();

                } else {
                    bar.setVisibility(View.GONE);
                    String message =
functions.decrypt(json.getString("message"));
                    Toast.makeText(getApplicationContext(),
message, Toast.LENGTH_LONG).show();
                }
            } else {
                bar.setVisibility(View.GONE);
                Toast.makeText(getApplicationContext(),
```

```
"JSon success string is null", Toast.LENGTH_LONG).show();
                }
            }else{
                bar.setVisibility(View.GONE);
                Toast.makeText(getApplicationContext(), "JSon
object is null", Toast.LENGTH_LONG).show();
            }
        } catch (JSONException e) {
            bar.setVisibility(View.GONE);
            Toast.makeText(getApplicationContext(), "Error try
again later.", Toast.LENGTH_LONG).show();
            e.printStackTrace();
        }
}
```

The key word for the JSON data is used to access each of the data received from the server. From the above code json.getString("**success**") is used to access the value of the success to know if authentication was successful or username and password incorrect. Once the success value is 1, the member page is launched but if 0, the user is alerted with a message of incorrect login details.

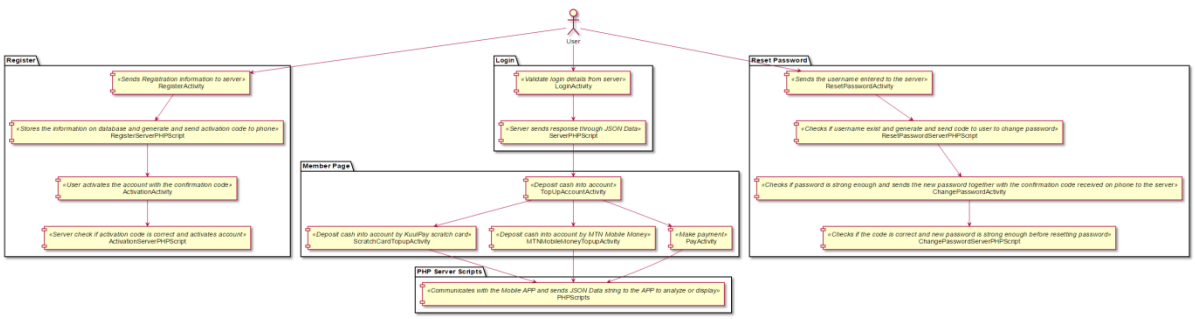

Figure 10. Package Structure UML Diagram

3.2. The Web App

The web application is developed using HTML, CSS, JavaScript, Ajax and PHP script.

HyperText Markup Language (HTML) is the standard markup language for creating web pages and web applications.

Cascading Style Sheet (CSS) is a style sheet language used to describe the presentation of a web page in markup language.

JavaScript (JS) is the programming language of HTML and the web.

Asynchronous **J**avaScript **A**nd **X**ML (AJAX) is not a programming language but uses a combination of a browser buit-in XMLHttpRequest Object to request data from a web server and JavaScript and HTML Dom to display or use the data.

This enables web pages to be updated asynchronously by exchanging data with a web server behind the scenes, making it possible to update parts of a web page, without reloading the whole page.

How Ajax Works

1. An event occurs either by a page load or a button clicked
2. XMLHttpRequest object is created by JavaScript and HttpRequest is sent to the server
3. The server processes the HTTPRequest and creates a response which sends the data back to the browser.
4. The borwser then processes the returned data using JavaScript and updates the page content.

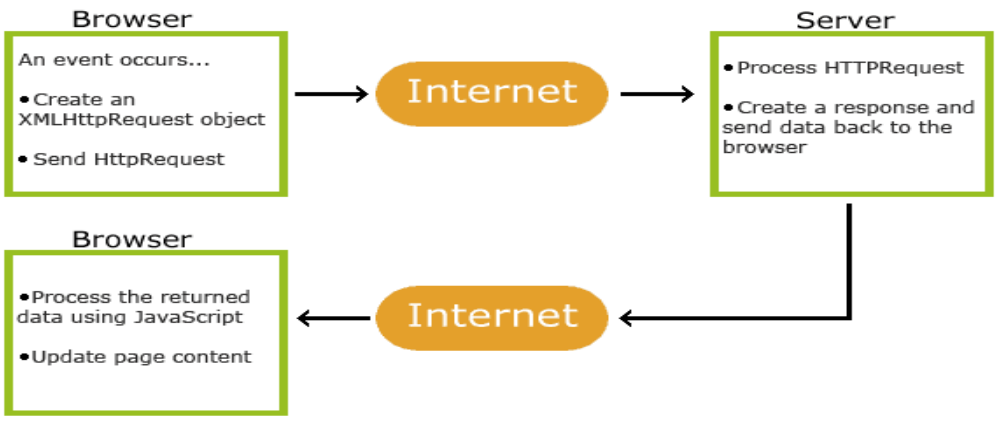

Figure 11. How Ajax Works

3.2.1. Interface Implementation

The web application home page is slightly different from the mobile application. On the web application, the home page briefly describes what KuulPay is about and showcases the uploaded fundraising projects and the percentages of the contributed amount as compared to the targets.

The **Login** and **Sign Up** buttons is placed on the front page in order for existing members to login and new members to sign up to the payment portal. The member page is designed to look exactly like the mobile application developed. The interface is developed to be responsive so that it fits all devices accessing the web application.

It is impossible and impractical to design a new version of the web application for each and every screen size and device. The practical would be to have a single interface that can adapt to every screen and presentable to all devices.

CSS is used to ensure this responsiveness of the web application to adapt to all screen sizes.

The CSS script that detects the dimension of the screen of the device browsing the website (**Media Queries)** is used to adjust the page depending on the dimension of the screen.

```
@media only screen and (max-width: 640px) {
        Sets of rules are stated between these curly brackets.
}
```

The special styles to make the web page adjust to the screen is placed in the curly bracket of the above style sheet command.

This set of rules makes it possible to create fluid designs that adapt without distortion or loss of quality to the viewer's device.

Different CSS rules is applied in order to obtain different layouts, depending on the width of the display window afforded to the content.

To make the appearance of the web application fit on the mobile device, certain divs with inline-block display property are given display block property to make them align vertically instead of horizontal. These divs are also given dimension width of 100% to cover the entire width of the screen as shown in the code below:

```
@media only screen and (max-width: 640px) {
        .block-container{
                display:block ! important;
                width:100%;
        }
        .block-container.right{
                width:100% ! important;
                float:none;
                padding-right: 20px;
                padding-left: 4px;
        }
}
```

The !important rule is used to override any other property of the attribute. This makes the site more adaptable to the device accessing the web application.

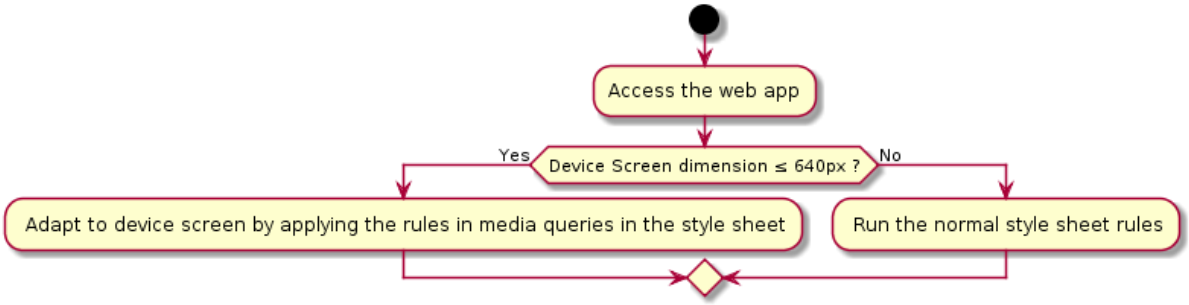

Figure 12. Adapting to Device Screen by Media Queries UML

3.2.2. Security Implementation

There are also four security features of the web application similar to the mobile application. This is explained as follows:

3.2.2.1. Login Security

Just like the mobile application, the password that the user uses is validated during sign up or changing of password to ensure that it is strong enough and difficult to guess. Once there is a failed login for 3 consecutive times, the account is blocked and the user is alerted with a SMS alert to contact KuulPay to reactivate his account and encouraged to change his username if he is not aware of the login attempt on his account.

3.2.2.2. Data Security

The only encryption of packets from the browser to the server is achieved through the "The HyperText Transport Protocol Secure" (https). The https is installed on the server to achieve this security.

3.2.2.3. Authentication Token Security

A code is sent to the KuulPay user's phone for every debit financial transaction to use to confirm the transaction. This is to prevent an unauthorized person from carrying on transaction without the knowledge of the owner of the account as explained in the mobile application section.

3.2.2.4. Idleness Security

Just like the mobile application, a user is logged out for being idle for some time. This is to prevent others from having access to account which is already logged into and unattended.

3.2.3. Key Functionalities Implementation

In order to integrate with MTN Mobile Money payment portal, KuulPay had to use their API to send bill prompt alert to their customers to confirm payment.

Once a bill prompt is instantiated, MTN Mobile Money gives us a response after maximum of about one minute.

The order number is recorded on the database once bill prompt is instantiated and this is used to update the payment status once the response arrives from the MTN Mobile Money payment server.

KuulPay immediately updates customer making the payment of either a successful or unsuccessful payment. Once successful payment is confirmed from the MTN Mobile Money call-back response, the transaction on KuulPay is executed based on the transaction types as explained in the XMLs of the design phase.

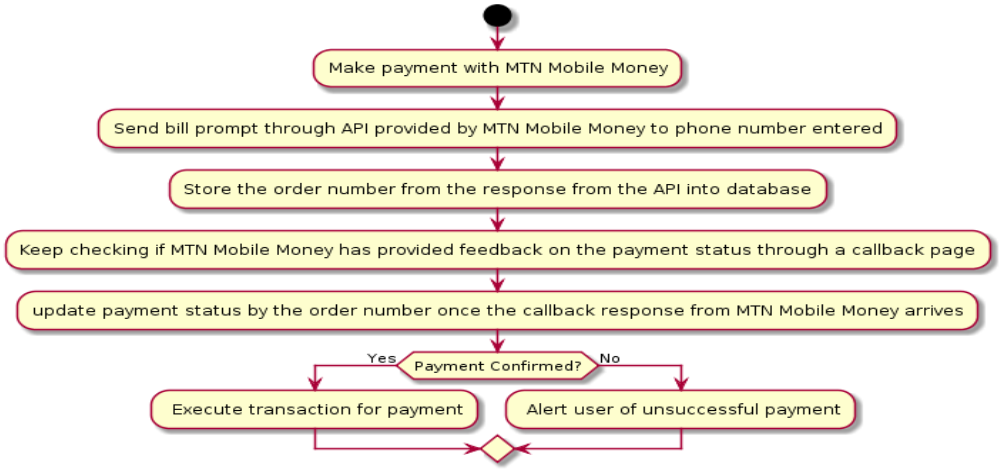

Figure 13. MTN Mobile Money Payment UML

The forms are also validated on the server by PHP script. The function below is used to ensure that phone number used is a Ghanaian phone number since the application is meant to be used in Ghana at the moment.

```
function valPhone($phone){
     $phone = str_replace(' ','',$phone);
     if(strlen($phone)==10){
          $first_char = substr($phone,0,1);
          if(!($first_char=="0")){
               return false;
          }else if(!ctype_digit($phone)){
               return false;
          }else{
```

```
                return true;
            }
        }else if(strlen($phone)==13){
            $country_code = substr($phone,0,4);
            $other_parts = explode("+233",$phone);
            if(!($country_code=="+233")){
                return false;
            }else if(!ctype_digit($other_parts[1])){
                return false;
            }else if(!(strlen($other_parts[1])==9)){
                return false;
            }else{
                return true;
            }
        }else if(strlen($phone)==14){
            $country_code = substr($phone,0,5);
            $other_parts = explode("00233",$phone);
            if(!($country_code=="00233")){
                return false;
            }else if(!ctype_digit($other_parts[1])){
                return false;
            }else if(!(strlen($other_parts[1])==9)){
                return false;
            }else{
                return true;
            }
        }else{
            return false;
        }
}
```

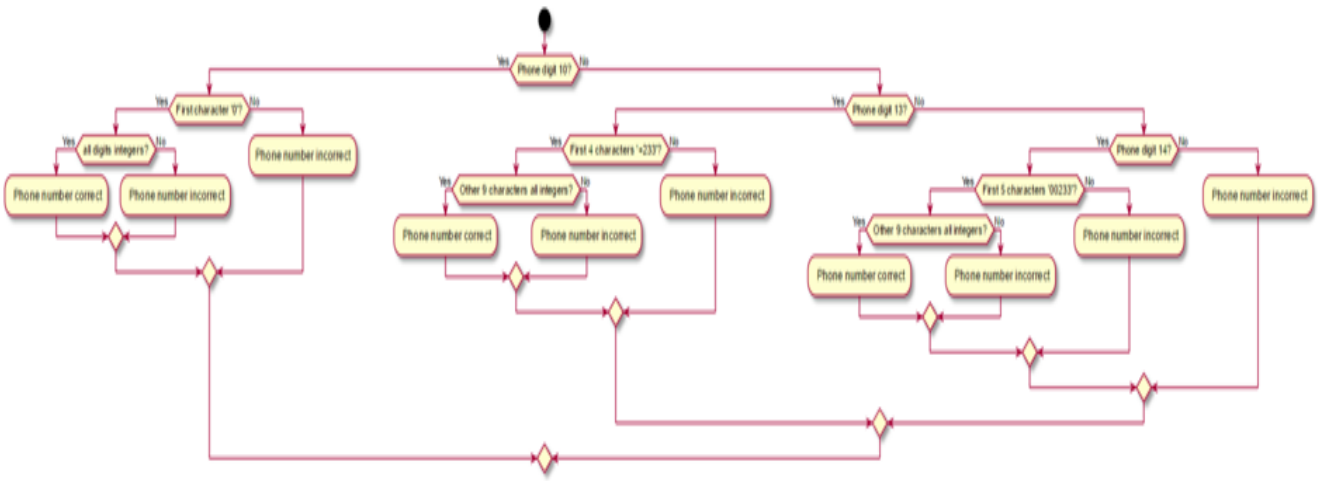

Figure 14. Phone Validation UML

4. INTEGRATION , TESTING AND ANALYSIS

Dahlberg et al. (2007:11) as stated in the literature review identified cost and "usefulness" as important adoption factors for a new M-Wallet. It is therefore necessary to design an e-commerce platform which will be referred as "KuulShop" which has the KuulPay payment system already integrated so customers with or no Information Communication Technology (ICT) or programming knowledge can use the KuulPay to run their online shops.

The KuulShop e-commerce has a management portal where customers can manage their online shop. A customer only sign ups on KuulPay and request for merchant account activation. Once the application is accepted, KuulPay gives the merchant a public ID and a private key to use to identify and authenticate itself during the online transaction. The merchant only records the given merchant ID and key in his KuulShop administrator panel to enable receiving payment through KuulPay.

For already existing E-commerce platform, a form is generated by the merchant with his public merchant ID and the private key which is authenticated on the KuulPay platform. The merchant can add the KuulPay payment system so buyers can click on the button to be directed to KuulPay for payment.

4.1. Integration into Kuulchat Website

Kuulchat is a social network with over nine thousand users especially students in Ghana for socializing and selling. Before adding the KuulPay payment portal, students only post their selling items and interested ones call the seller and arrange to meet and collect the item. Since it is now possible to make payment through KuulPay, the buying and selling feature of the site is redesigned and KuulPay integrated in the checkout process. Students now post their selling items and select the campus they are located. The interested buyer adds the product to his cart and selects his method of payment (MTN

Mobile Money | KuulPay or Cash on Delivery). The seller is alerted through SMS message and takes the selling item to the Kuulchat office on campus so that the buyer can verify the item and once accepted, Kuulchat gives the paid amount to the seller. If not accepted, the money is refunded to the buyer.

The KuulPay online payment button is written by the HTML and PHP Code below:

```
$merchant_id = ""; // The merchant public ID
$merchant_key = ""; // The merchant private key for
authenticating on KuulPay payment portal
$amount="";// The amount to be paid on the KuulPay portal
$order_id ="";// The order id
$order_ref="";// The order reference
$order_desc="";// The order description
$return_address = ""; // The web address the buyer will be
directed once payment confirmed
$cancel_address = ""; // The web address the buyer will be
directed once payment is cancelled.
The authentication code which would be verified on the
KuulPay platform is also generated with md5 and changed to
upper case as shown below:

$authcode =
strtoupper(md5($merchant_key."|".$merchant_id."|".$amount.
"|".$order_id.

"|".$order_ref."|".$order_desc."|".$return_address."|".$can
cel_address));

<form method="POST"
action="https://kuulpay.com/onlinepayment.php">
```

```
                    <input name="MERCHANT_ID" type="hidden"
value="'.$merchant_id.'">
                    <input name="AMOUNT" type="hidden"
value="'.$amount.'">
                    <input name="ORDER_NUMBER"
type="hidden" value="'.$order_id.'">
                    <input name="REFERENCE_NUMBER"
type="hidden" value="'.$order_ref.'">
                    <input name="ORDER_DESCRIPTION"
type="hidden" value="'.$order_desc.'">
                    <input name="RETURN_ADDRESS"
type="hidden" value="'.$return_address.'">
                    <input name="CANCEL_ADDRESS"
type="hidden" value="'.$cancel_address.'">
                    <input name="AUTHCODE" type="hidden"
value="'.$authcode.'">
                    <input type="submit" value="MTN Mobile
Money | KuulPay >>" />
                </form>
```

As it can be seen in the form, the key is hidden from the website users. This is a private key which the merchant uses to communicate with the KuulPay payment portal. This key is known by only the two parties (The merchant and KuulPay) and that makes it safe and secure. Only the public ID is visible to the website users.

At the KuulPay end, the key is accessed by the merchant public ID and is used to generate the authentication code with the form data. Once the authentication code (AUTHCODE) from the merchant's website matches with the generated authentication code on the KuulPay platform, the transaction is carried, otherwise rejected.

On the return or cancel address, KuulPay also generates authentication code and add it to the addresses and the data passed in the address is accessed through the PHP

$_GET["] command. The merchant then generate the authentication code with his public ID, key and the data passed in the address. If the generated authenticated code matches with the one sent by KuulPay, the order payment is updated either paid on the return address or cancelled on the cancel address.

Authentication code will never match if any of the data in the address is modified.

This is explained further by the UML diagram below:

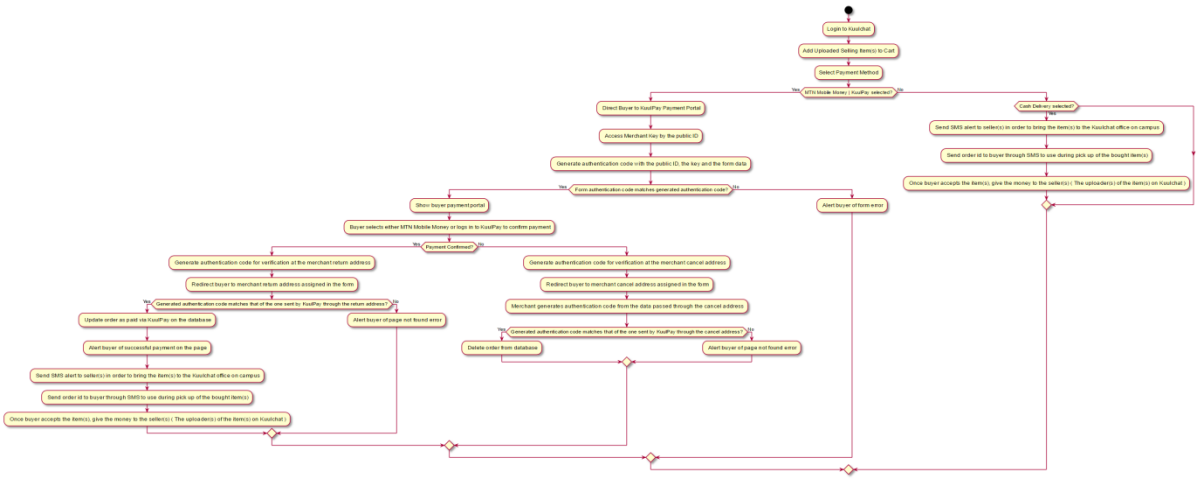

Figure 15. KuulPay Integration on Kuulchat Site

The graphical output of the integration is shown in the figures below:

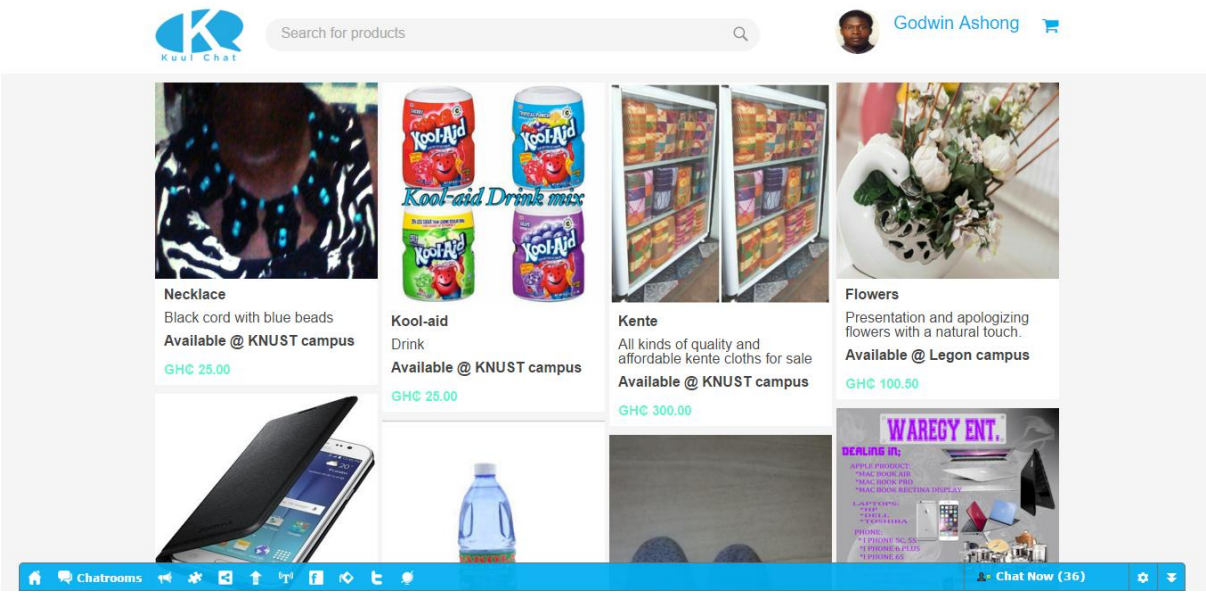

Figure 16. The Kuulchat Online Shop

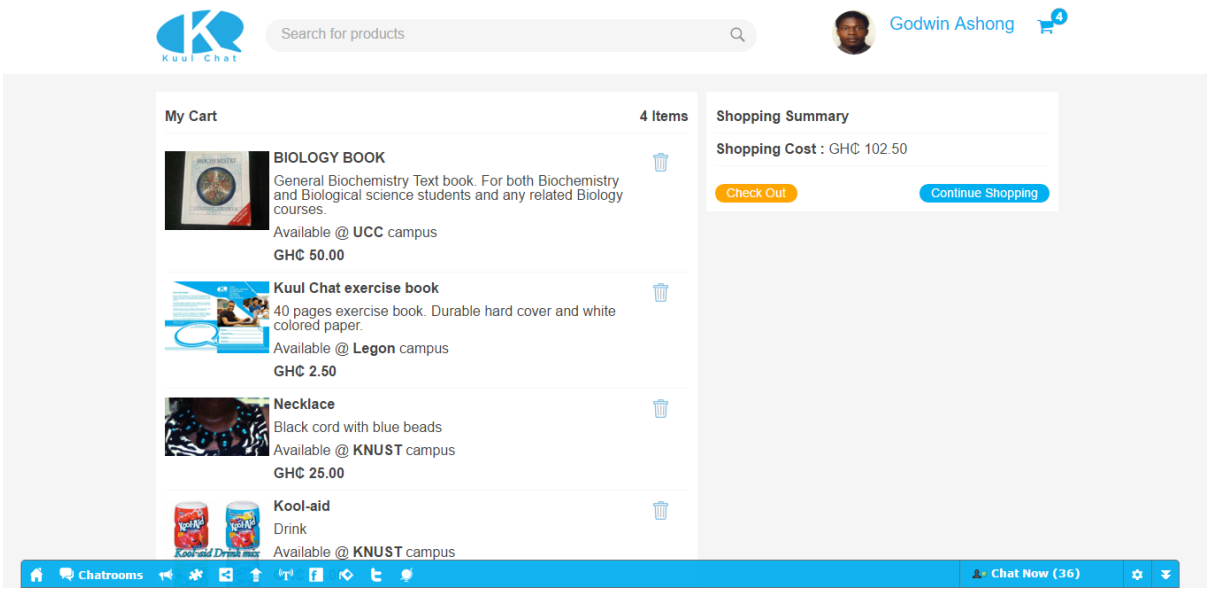

Figure 17. Showing Cart Content for payment checkout

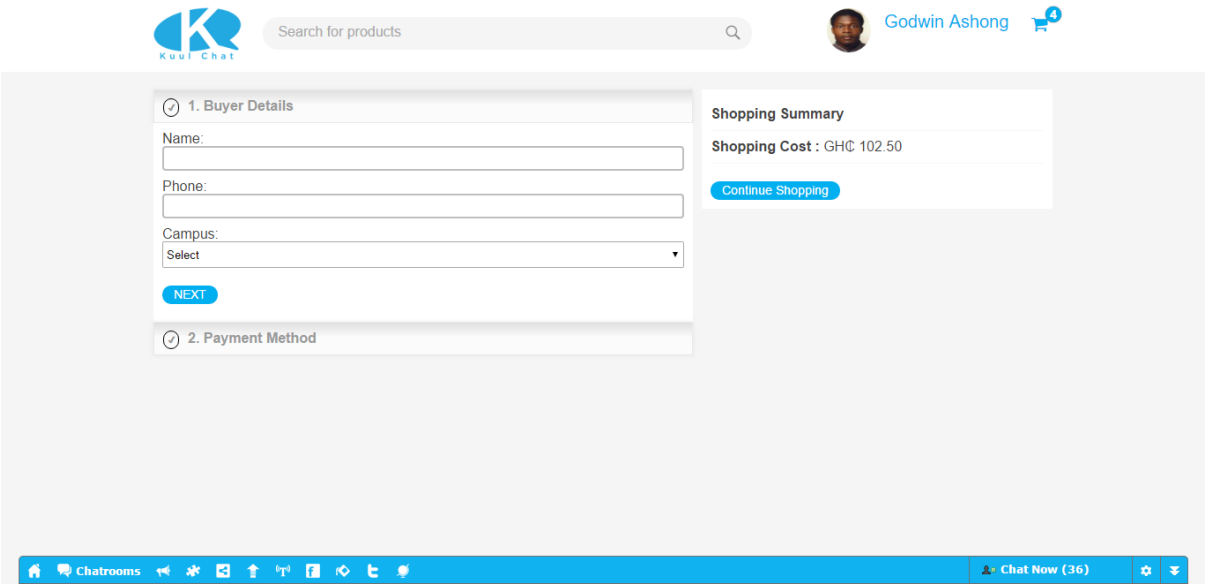

Figure 18. Step 1 of the checkout (Buyer's Information)

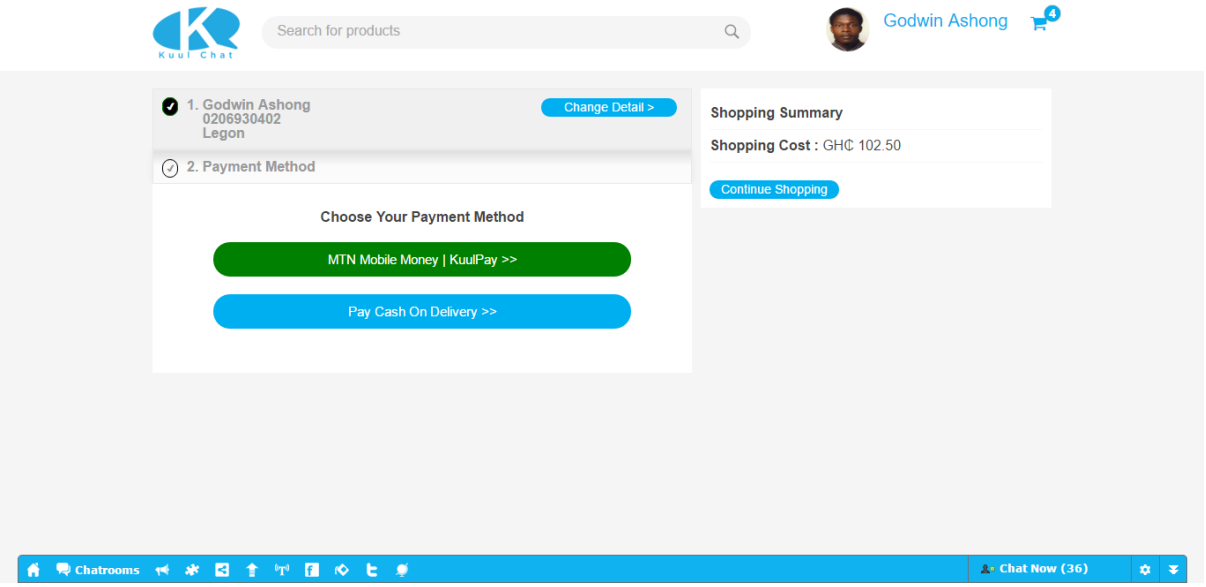

Figure 19. Step 2 of the checkout (Payment Options)

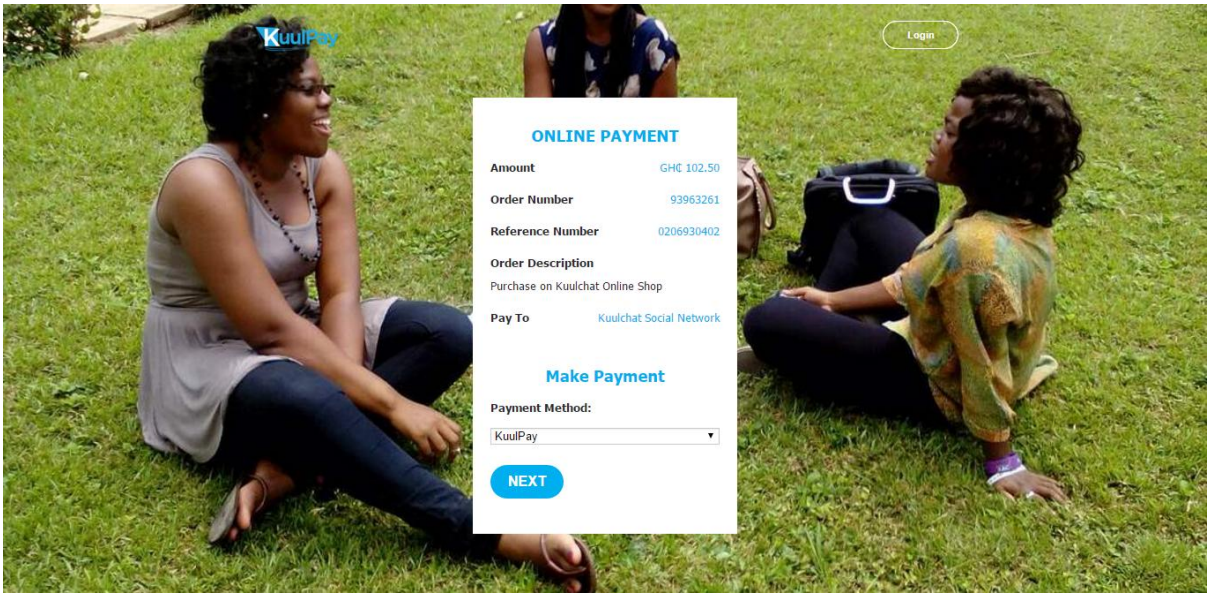

Figure 20. Pay with KuulPay Account

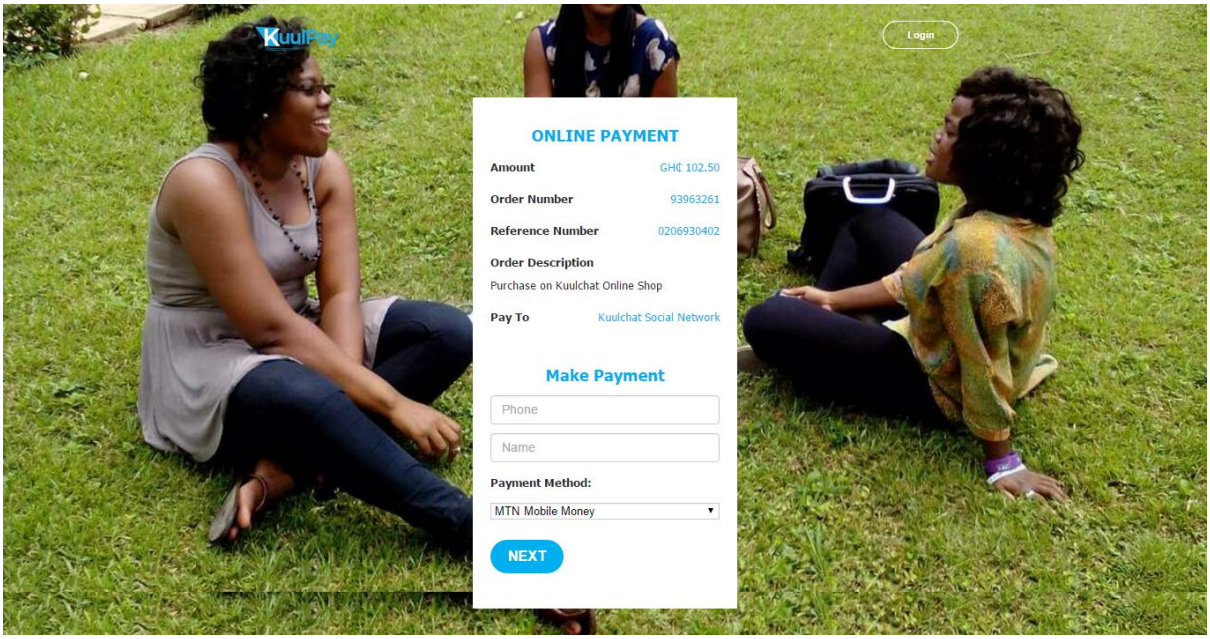

Figure 21. Pay with MTN Mobile Money

The bill prompt is sent to the buyer's MTN Mobile Money phone number entered to confirm transaction. Once MTN Mobile Money confirms on our server that the buyer has made payment, the payment status is updated and transaction type executed and buyer is directed back to the merchant website(the return address indicated in the form)

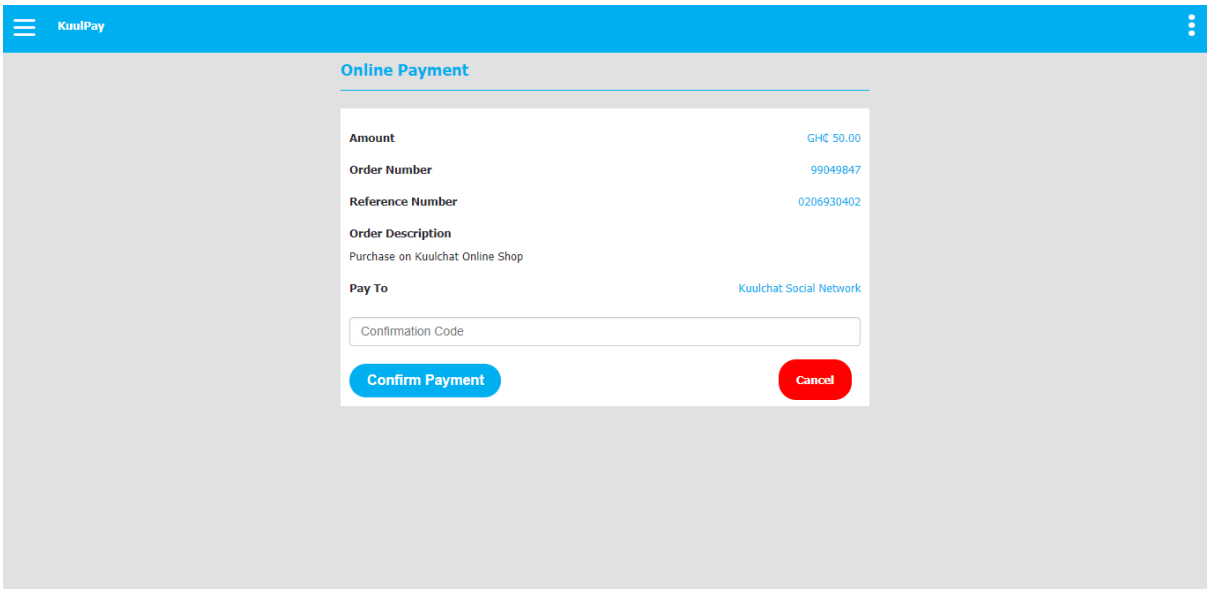

Figure 22. Payment Confirmation With Digit Sent To Phone (KuulPay Payment Option)

Once the KuulPay user confirms the payment, the money is deducted from his account and the transaction type executed. A callback response is sent to the merchant's return address and finally the buyer is directed to the return address of the merchant indicated in the form.

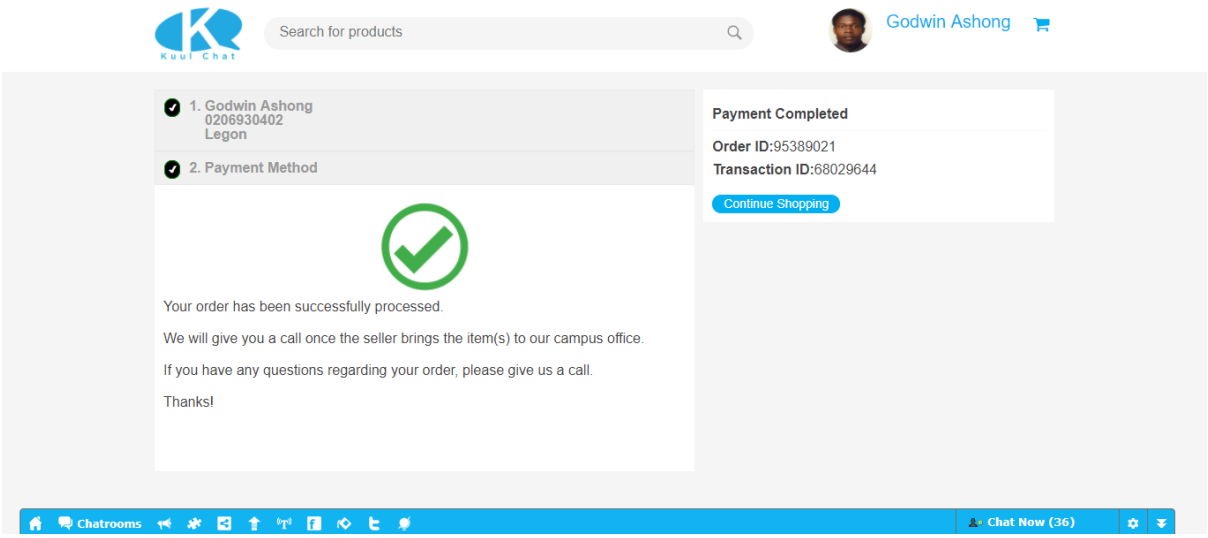

Figure 23. KuulPay successful payment

As shown by the pictures above, KuulPay online payment system is integrated to the Kuulchat social network and this enables student to buy online. On the KuulPay payment portal, customers who uses MTN Mobile Money Wallet can still make payment via KuulPay. A user with enough balance in his account can directly login to his KuulPay and confirm payment by the SMS sent to his phone. Once payment made, the buyer is directed to the Kuulchat Shop page to update the payment status of the transaction.

4.2. Implementing KuulShop on Prevas Motors Website

Pre-vas motors is a car dealing company selling brand new and old cars. The company is located in Ghana. The KuulShop web application which has the KuulPay payment system already integrated is installed on their website (prevasmotors.net). The online shop is managed through the administrator panel of the KuulShop Web Application.

The installation of the KuulShop is easy and in order to acquired more customer base using the KuulPay payment portal, the KuulShop is sold at a very low cost to entice businesses who want to venture into e-commerce to accept KuulPay as payment option.

The web application is simply installed by first entering the database information (database link, database name, database username and password) in the configuration file.

The database tables for the web application is created by running the install.php script thus weblink/install.php . After which the administrator logs in with the default username and password to the management panel.

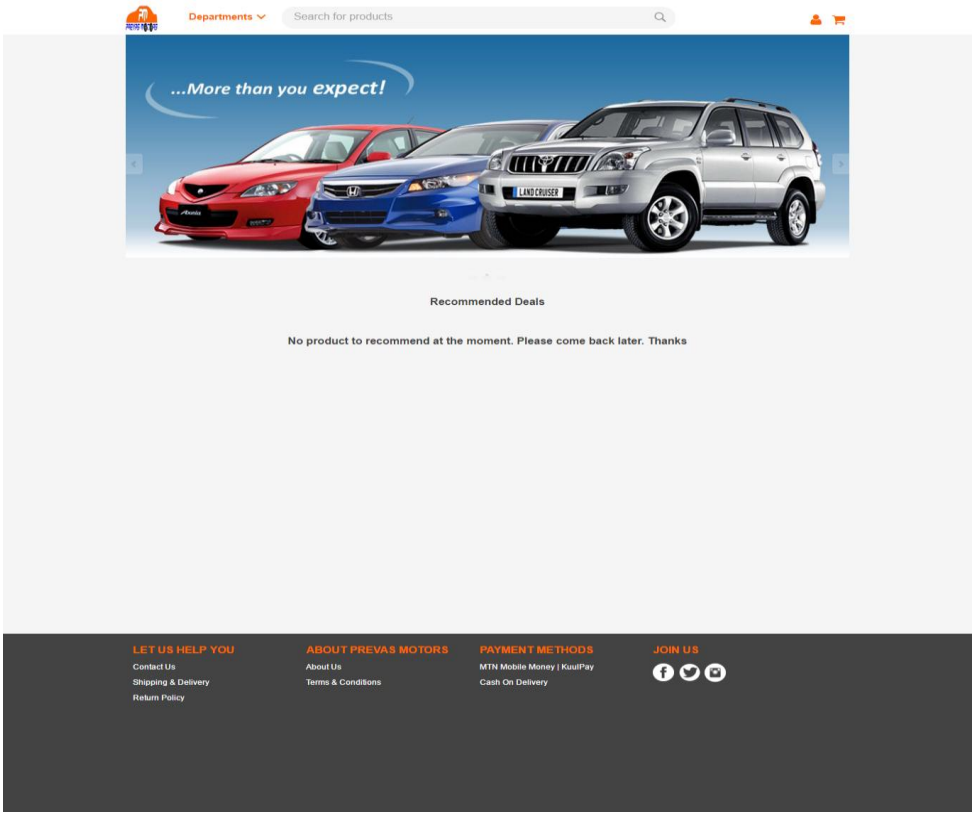

Figure 24. The Front page of the KuulShop Installed Before Adding Products

The administrator then logs in to the control panel to change his default username and password and manages the online shop. He records the category and subcategory of the products and upload products which is displayed on the online shop.

In order to accepted payment through KuulPay he must configure the KuulShop with his merchant ID and key by just recording those information he is given after activating his KuulPay account to a merchant account.

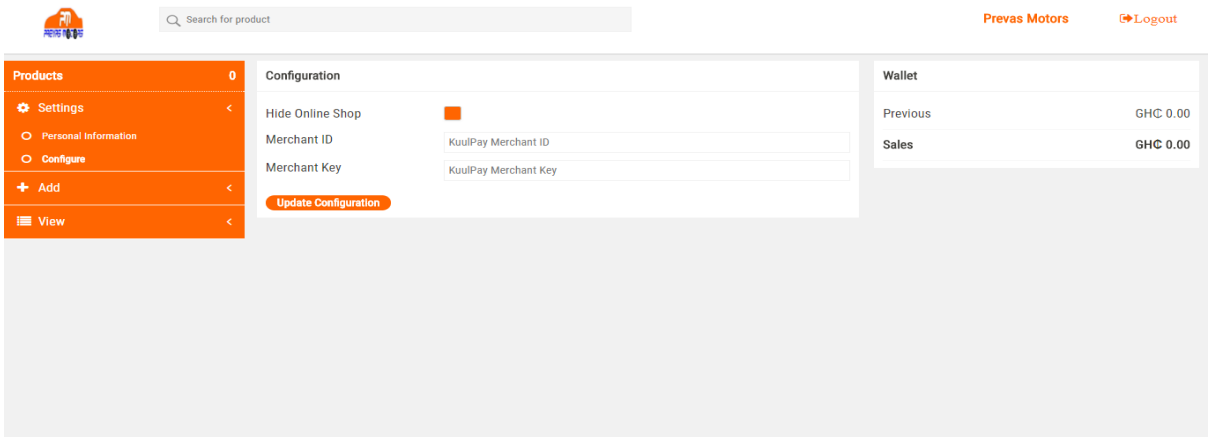

Figure 25. Configuration page for KuulPay Online Payment

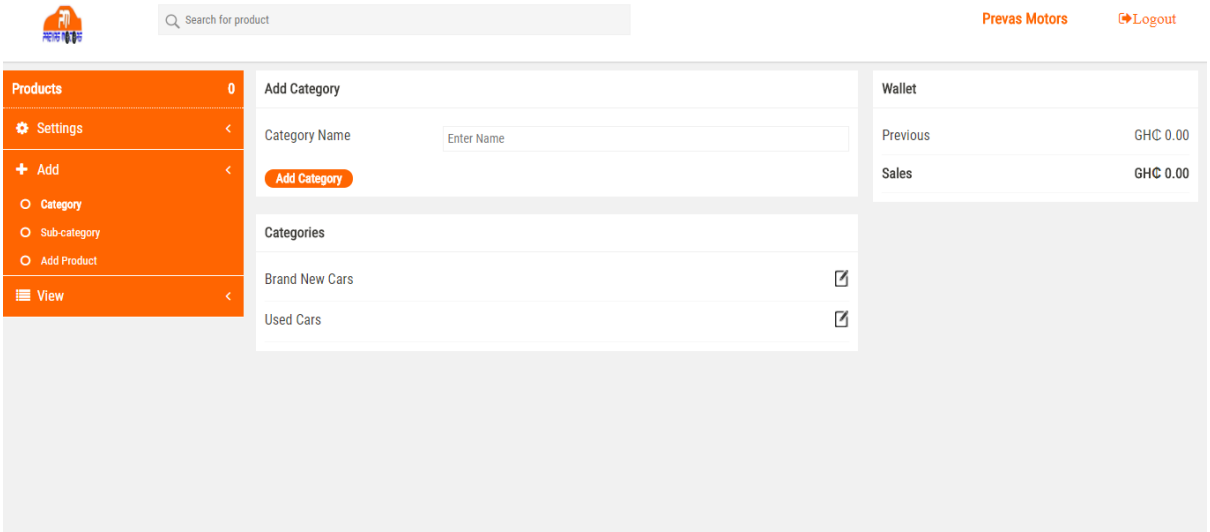

Figure 26. Adding main category

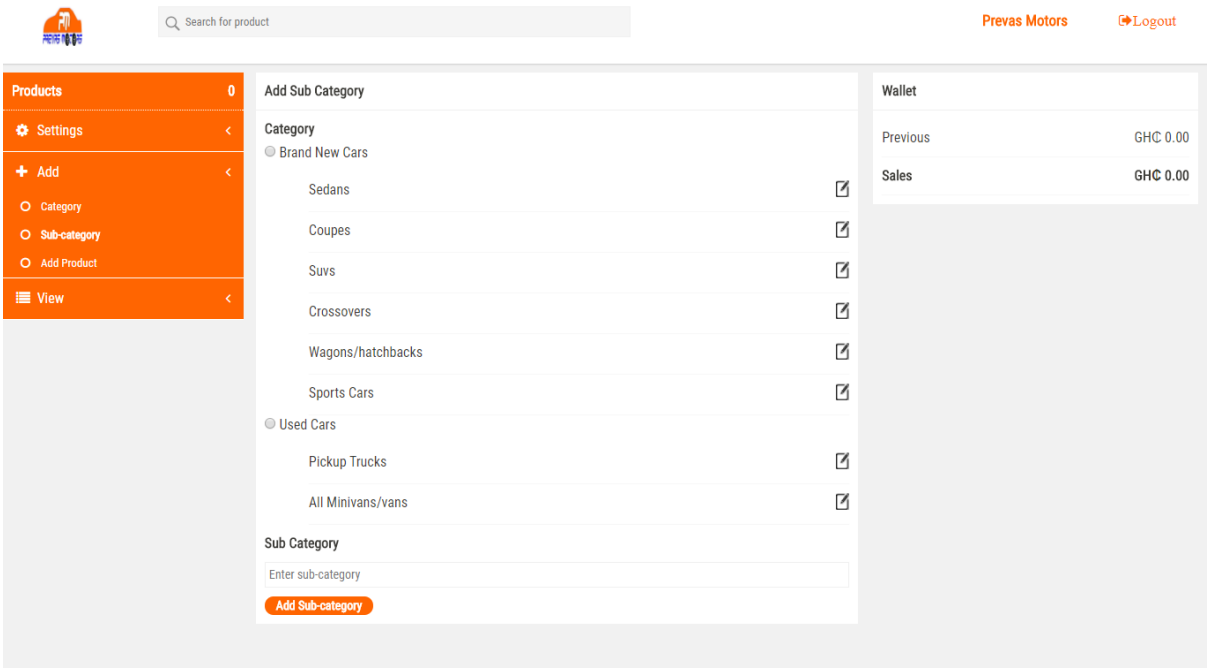

Figure 27. Adding subcategory to main category

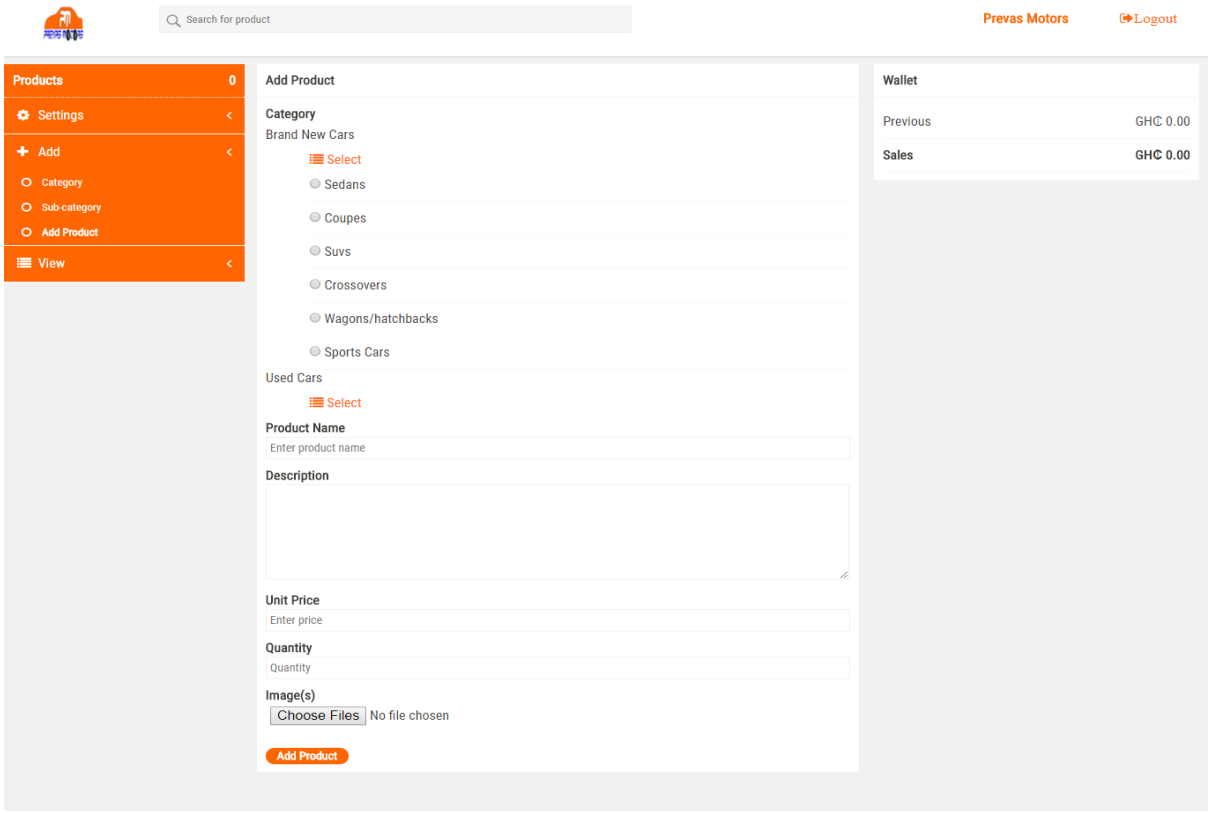

Figure 28. Adding product

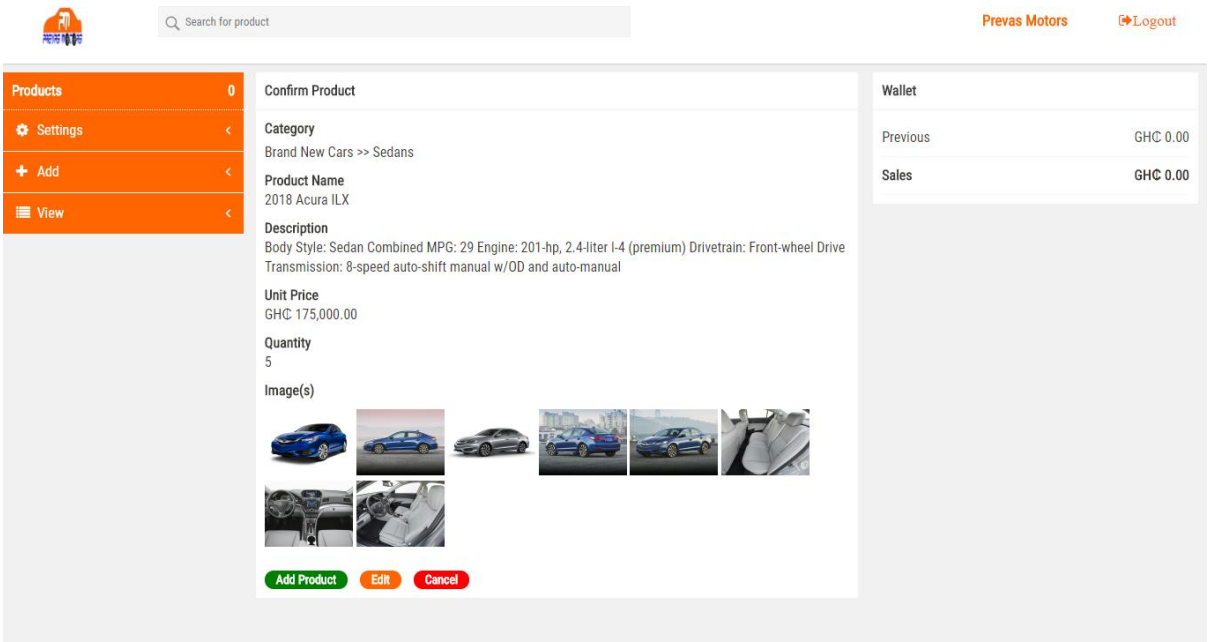

Figure 29. Confirming Product

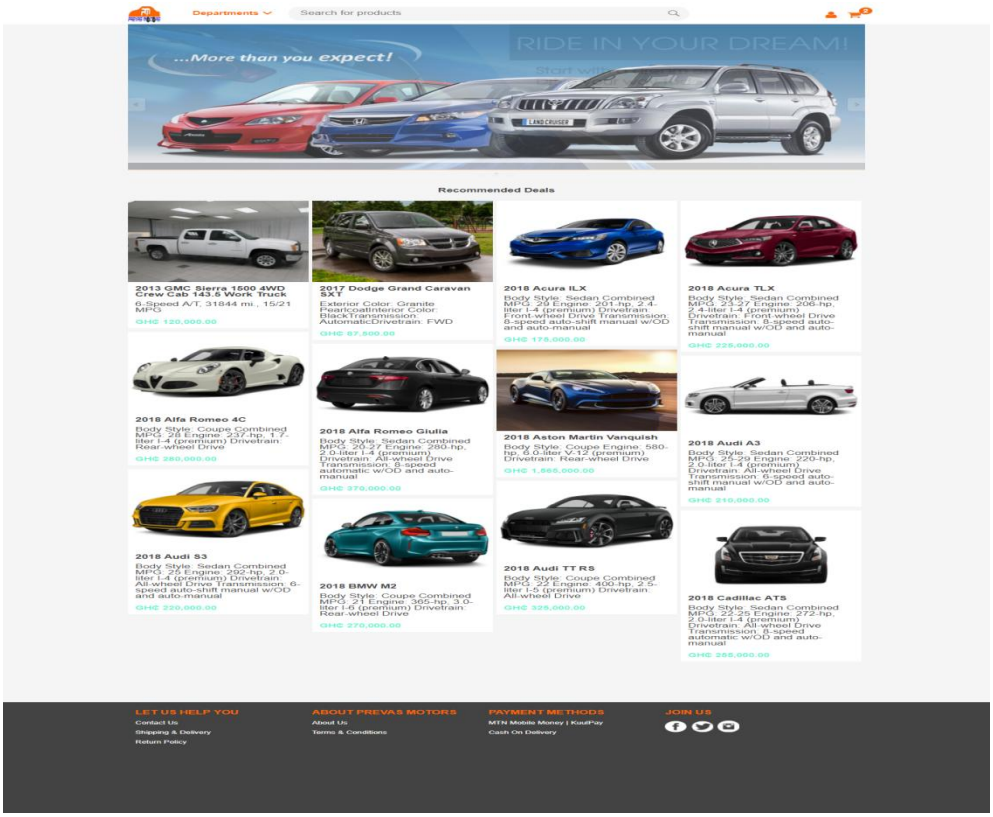

Figure 30. Online Shop after adding products in the KuulShop administrator panel

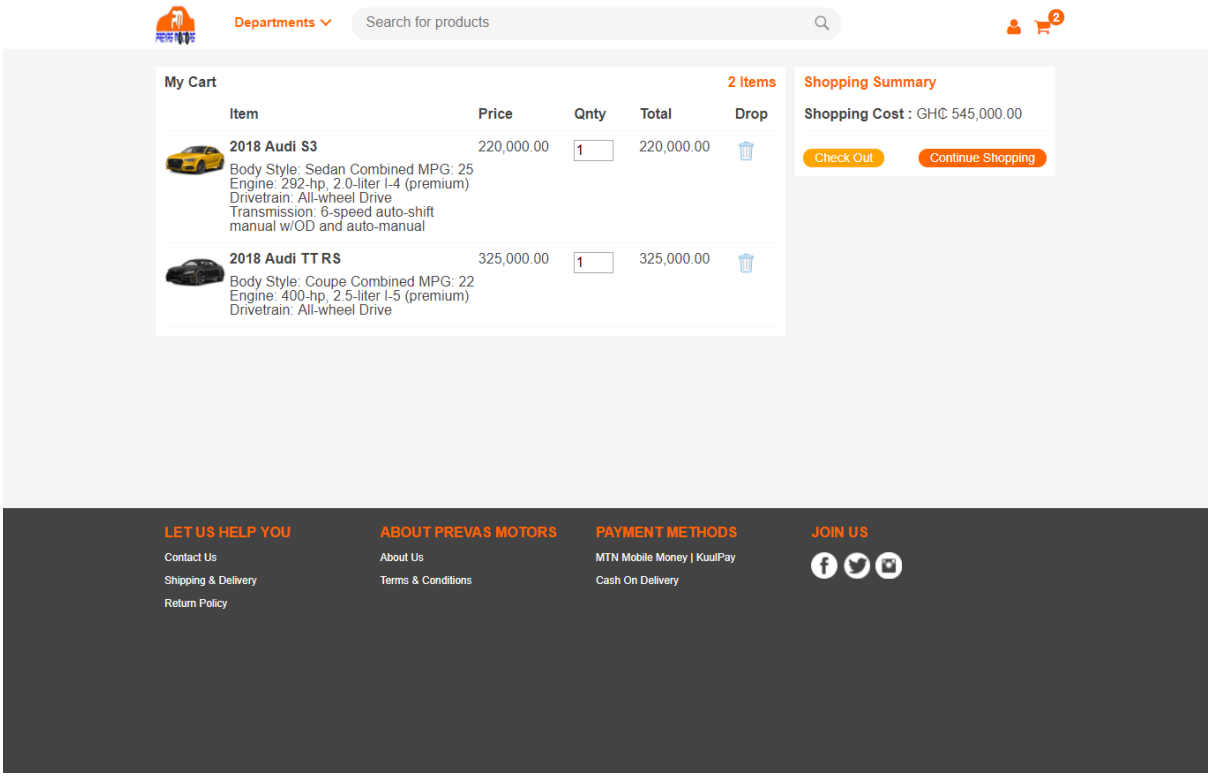

Figure 31. Cart content for checking out

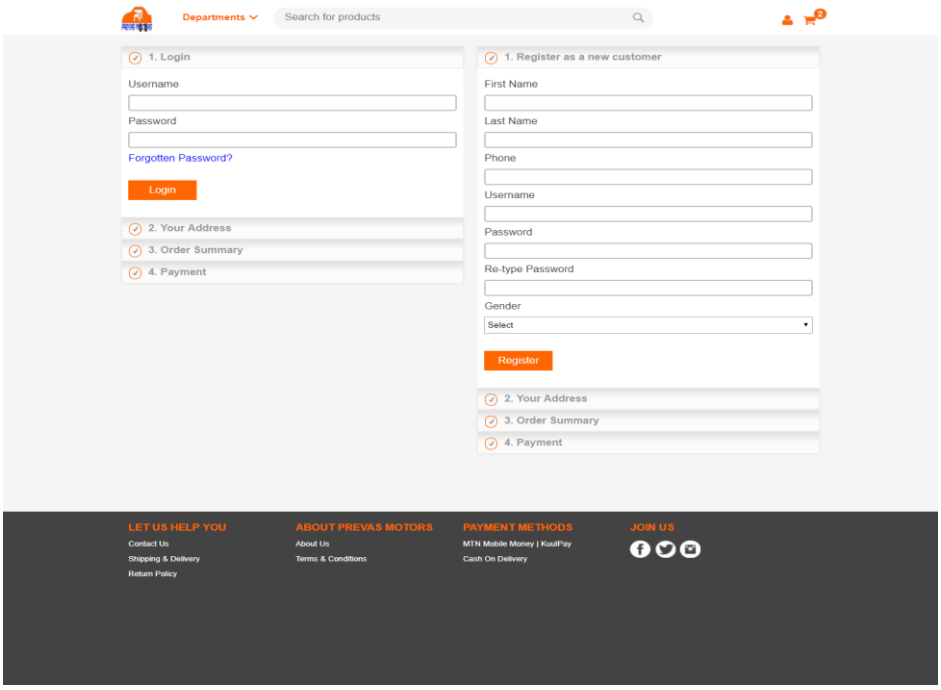

Figure 32. Logging In to checkout

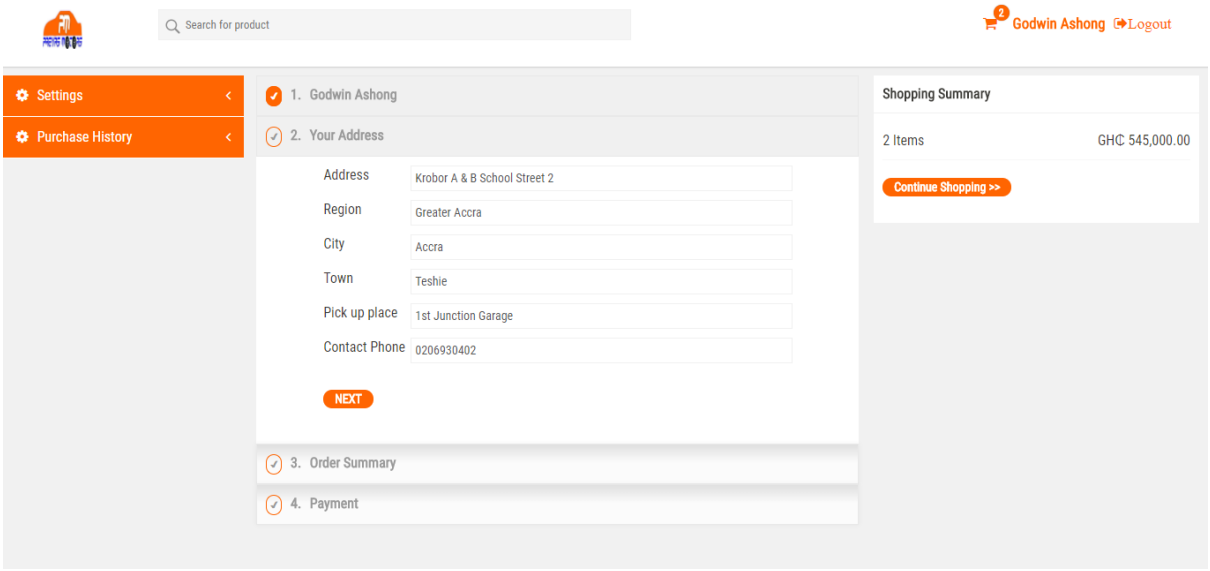

Figure 33. Checking out step 2

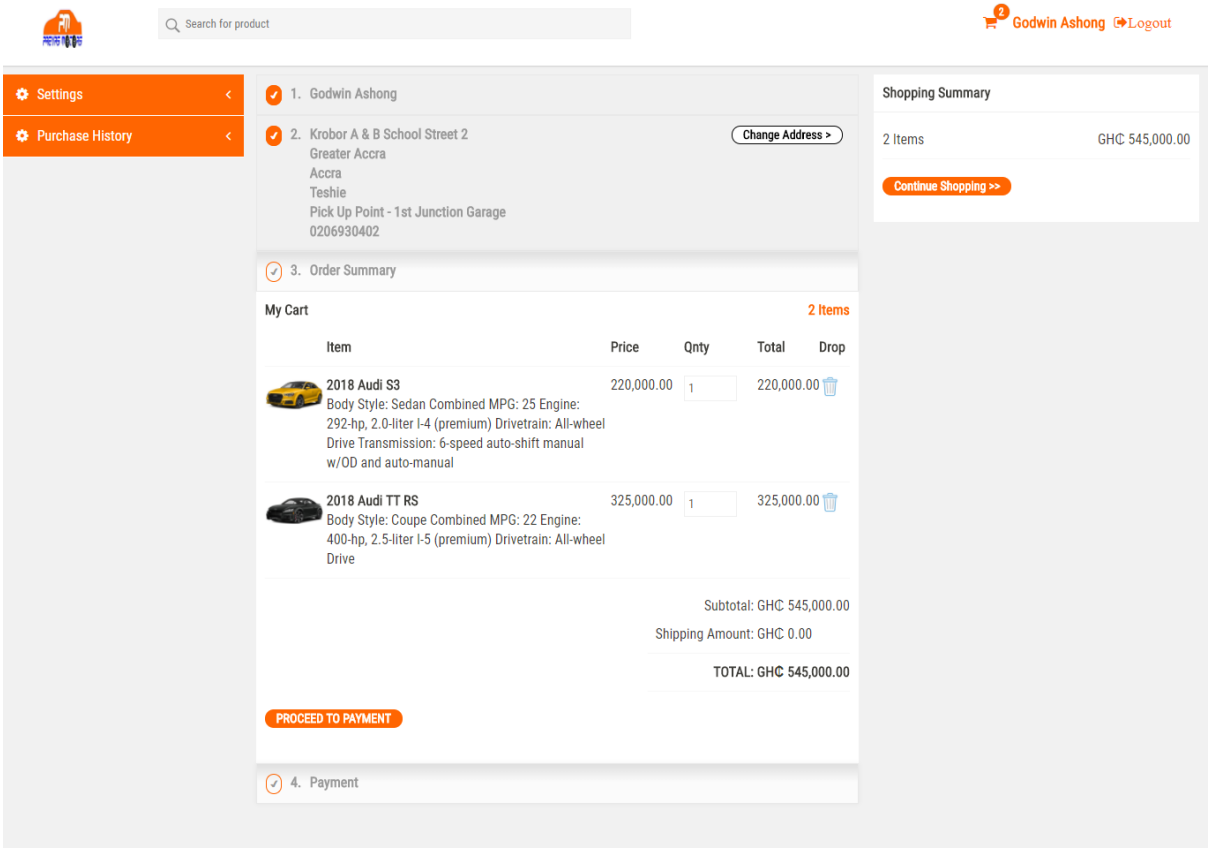

Figure 34. Checking out step 3

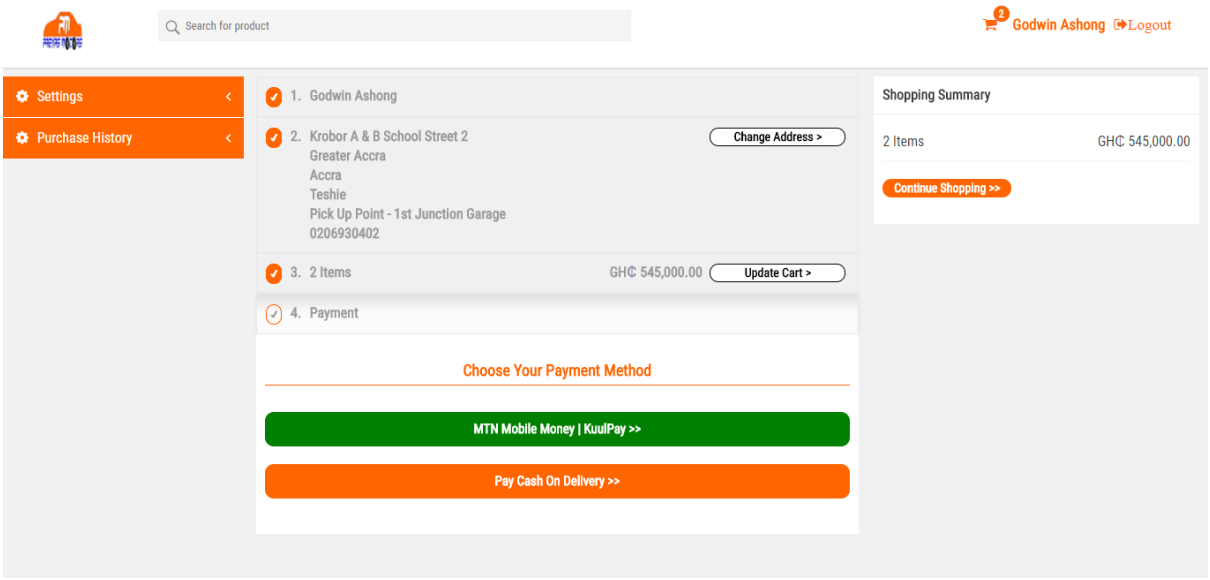

Figure 35. Check out with already integrated KuulPay Payment Portal

Once the "MTN Mobile Money | KuulPay " button is clicked, the buyer is directed to KuulPay payment portal to make payment. If the payment is successful, the buyer is directed to the successful payment page which updates the payment status of the transaction as paid. If the buyer cancels the payment, the buyer is redirected to the cancel page of the merchant payment page and the order is deleted from the database.

The KuulShop online shop with the KuulPay payment system integrated already will help promote the KuulPay payment portal as it is simple to integrate. Customers only manages the site.

4.3. Fund Raising Feature

Aside the debit and credit (withdrawals and deposits), the fundraising feature of KuulPay also makes it useful in the Ghanaian community. Raising of funds on the site is simple. One only needs to fill a project form and indicate when the project will be ending. Once the project is submitted, KuulPay read proof the project to see if it is

appropriate for the public. Once a project is accepted, it is available to the public or private individuals to make contributions to the project.

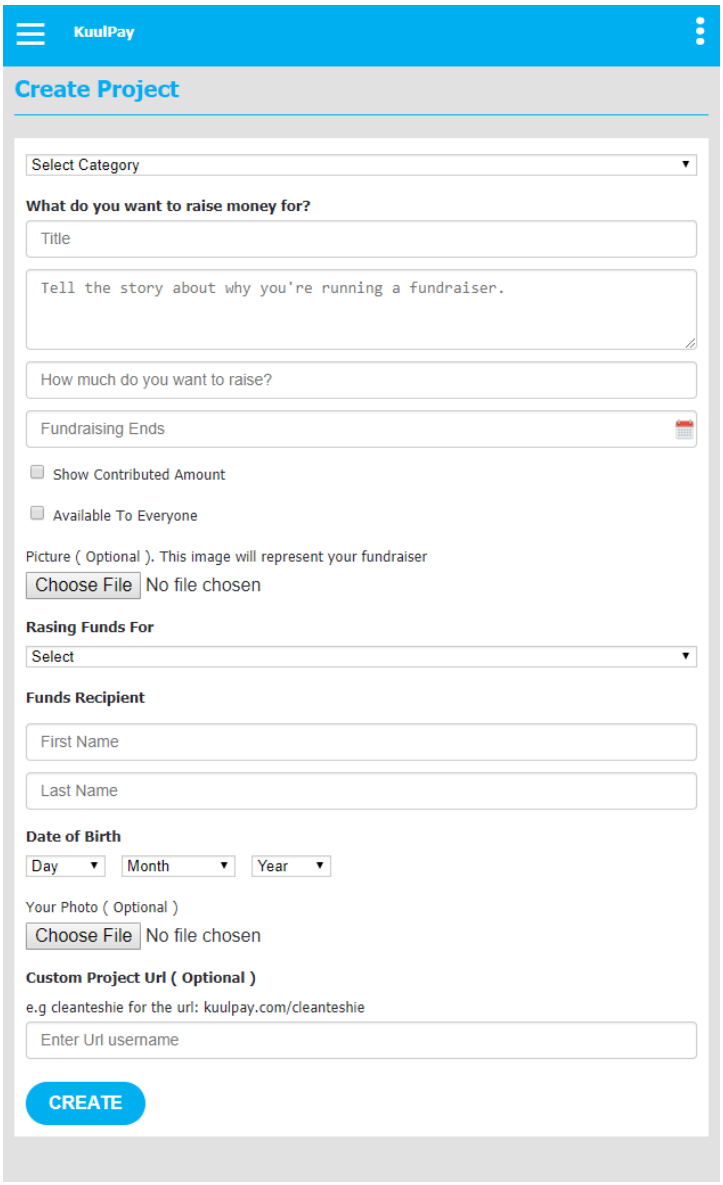

Figure 36. Form for submitting project for contributions

For a project which is stated to be available to everyone, KuulPay displays such projects on the front page of the web application so people can see and make contribution towards the project. For a private project, the project owner shares the link with selected few he wishes to request donations from. The contributor to a project can either donate anonymously or choice to show his details to the owner of the project.

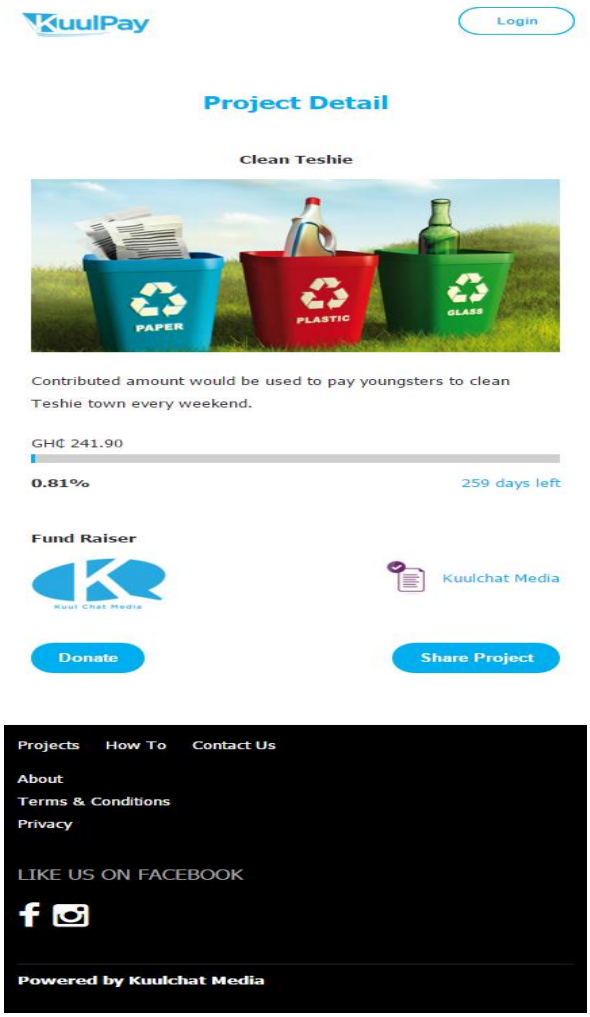

Figure 37. Contributions for a submitted project

Once the donate button clicked, the contributor can make the donation by his KuulPay account (for KuulPay User) or by MTN Mobile Money (for Non KuulPay user). Once payment is confirmed, the money is recorded and given to the owner of the project when the project due date expires.

KuulPay charges 3% of the contributed money and the rest is given to the owner. When a contributor chooses MTN Mobile Money as payment option, the MTN Mobile Money is automatically deducted from the contributed amount so the contributed money then become **amount donated - MTN Mobile Money charges.**

No charges is deducted when the contributor chooses the KuulPay payment portal, thus the contributed amount is still the donated amount. The contribution progress bar indicates how much of the estimated fund raising amount has been reached. This progress bar is absence only when the owner of the project indicates in the form that contributed money should not be shown to people.

4.4. Analysis of the KuulPay Application

This section would analyze the application developed base on the use cases and functional requirements stated in the preceding chapters. The developed application will then be compared to other popular existing m-wallets on the market.

4.4.1. Analyzing the developed application

The functional requirements and use case scenarios were taken into consideration when designing and developing the application.

Below are the functional requirements of the KuulPay Mobile Wallet:

1. The application should let a user deposit cash into his mobile wallet
2. The application should let a user withdraw physical cash from his mobile wallet
3. The application should let a user check his account balance
4. The application should let a user transfer money to another person (Whether a KuulPay user or a non user)
5. The application should let a user raise funds for a project

6. The application should be possible to integrate into other e-commerce website to enable KuulPay users or Non Users to make online payment through the application

These financial requirements were considered in the design process and successfully developed

4.4.1.1. The application should let a user deposit cash into his mobile wallet

This can be done by either buying a scratch card of amount equivalent to the electronic cash one wish to have in the account for transaction or topping up using MTN Mobile Money if one has MTN Mobile Money account.

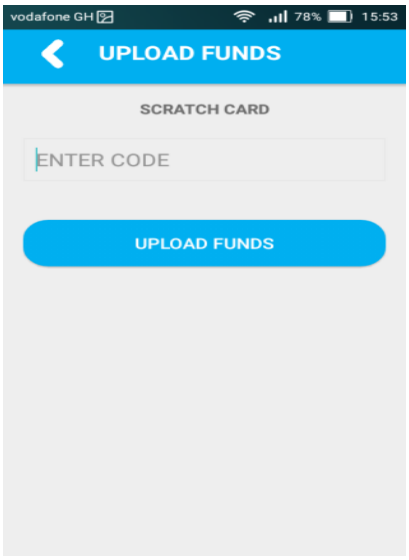

Figure 38. Topping up with KuulPay Scratch Card

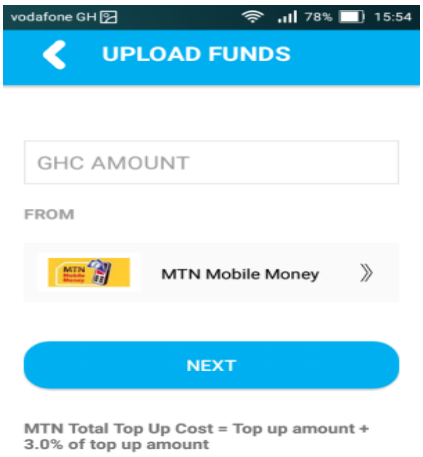

Figure 39. Topping up with MTN Mobile Money

4.4.1.2. The application should let a user withdraw physical cash from his mobile wallet

Physical cash can be withdrawn by generating a payment token in the account and using that token at a KuulPay merchant shop to do the withdrawal. The information generated on the token is asked at the merchant shop and once all questions relating the payment token is answered correctly, the physical cash is given. This feature can be used to send money to love ones by generating the token and given the details to them so they can make the withdrawal.

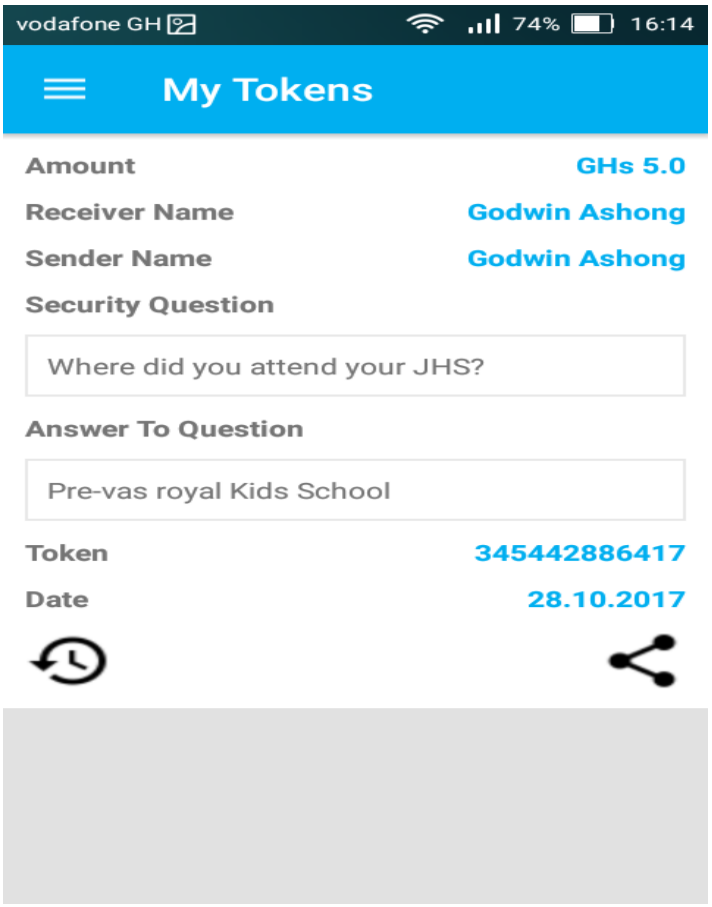

Figure 40. Token Generated For Withdrawing Cash At A Merchant Shop

The token can be restored to an account ones the account holder changes his mind of withdrawing the cash. Once restored to account, the KuulPay user receives both the withdrawing amount and the charges for the withdrawal. KuulPay charges some percentage for every withdrawal which the merchants also have some percentage of the charged amount to motivate them to make cash available always for withdrawals. So the merchants give physical cash to the KuulPay user who is doing the withdrawal and the merchant receives the equivalent amount in his KuulPay account in addition to commission received for the transaction.

4.4.1.3. The application should let a user check his account balance

The account balance and transactions carried is shown on the first page of the member page once logged in. At the moment in the first version of the KuulPay application, one must have internet access to login to his account to check his balance.

Figure 41. Account balance and transactions

4.4.1.4. The application should let a user transfer money to another person

To transfer money to another KuulPay user, one uses the phone number of the user on record. Once the phone number exist and the sender has enough funds in account, the money is transferred after confirmation from the sender by a code sent to his phone. The recipient of the money then receives SMS message of cash sent to his account.

For a non user, one has to generate a token payment and give the detail of the token to the person to use to withdraw the cash.

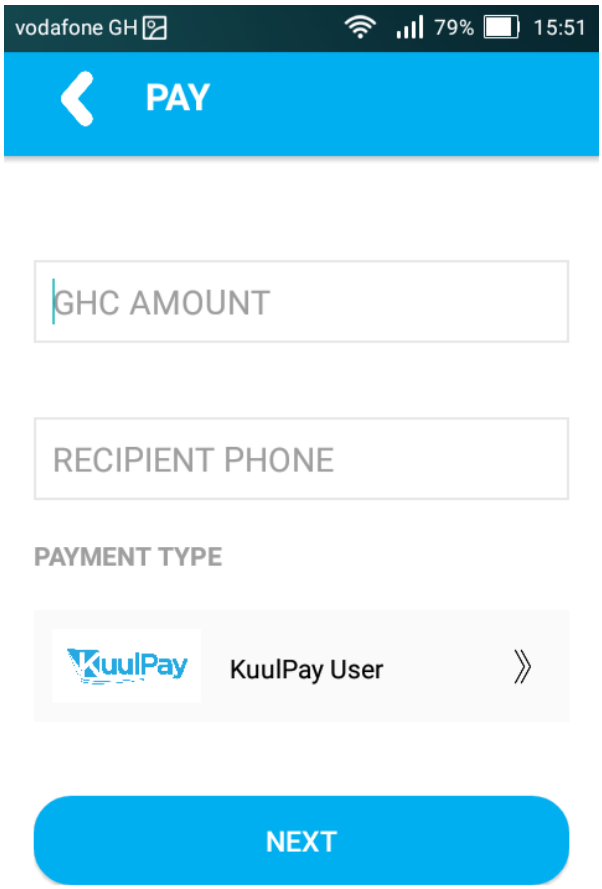

Figure 42. Transfer cash to another KuulPay User

4.4.1.5. The application should let a user raise funds for a project

As explained in section 4.3 , it is possible to create a project as shown in figure 36 and solicit for funds from friends or the public. Once the project deadline expires, KuulPay gives the money to the owner of the project after deducting the percentage charges from the generated funds.

4.4.1.6. The application should be possible to integrate into other e-commerce website to enable KuulPay users or Non Users to make online payment through the application

As explained in section 4.1 and 4.2 , two scenarios where used to demonstrate this functional requirement. The first case is Kuulchat which is already an existing social network website and the KuulPay payment portal is integrated into the site to enable buyers on the site to make payment to items bought. The second scenario was installing the KuulShop e-commerce which is developed by KuulPay and has already the KuulPay payment portal integrated so merchants only need to configure their merchant ID and Key and can manage the online application by creating categories of the products and uploading the products to be shown on the online store for purchasing.

KuulPay also added to the feature of the web application, the possibility for students to buy WAEC result checker with KuulPay on the KuulPay payment portal and the serial number and pin for checking their results is sent to their phone as SMS. A student will therefore sit in the comfort of his house and order for a WAEC result checker through KuulPay.

4.4.2. Limitations of the M-Wallet Developed

The KuulPay application is internet base and therefore one need to have internet access in order to use the application. This means that the application cannot be used in certain areas of Ghana that doesn't have good internet reception.

It is therefore necessary to partner with some of the telecommunication operators so KuulPay users can use USSD code to access their account and make transactions by dialling a unique code assigned to KuulPay for transactions.

4.4.3. Comparing KuulPay to Other Popular M-Wallets

It is necessary to compare the developed application to other popular existing m-wallets to see areas that needs to be improved in the subsequent version of the application as the customers of KuulPay grow. The lessons to learn from these m-wallets will also be discussed.

4.4.3.1. Alipay & WeChat Pay

Alipay holds 54% of the market share and WeChat Pay holds 40% of the market share of the payment systems in China. These two have products that only accept payment from their payment platform. For example, Taobao, the E-commerce platform of the Alibaba group only accepts payment from Alipay and WeChat social network also only accept payment from WeChat Pay. This forces the users to patronize the payment system in order to acquire certain services from any of these two giant payment portals.

WeChat is first and foremost a messaging app for sending text, voice, and photos to friends and family. It later added the payment portal to offer more services to its users.

For KuulPay also to strive in the M-Wallet business, it is necessary to develop a number of useful applications that has the KuulPay payment system already integrated to force people who need the service to patronize the KuulPay payment portal.

Table 2. Comparing Alipay to WeChat Pay

	Alipay	**WeChat Pay**
Devices Supported	All smart phones, tablets, and computers	Most smart phones
Financial Management Options	Transaction Include: • Money transfer • Bill sharing • Bill payments • E-commerce payments • Mobile balance top-up • Bank account balance checks • Hotel booking • Ticket purchasing	Transaction include: • Money transfer • Bill payment • E-commerce payments • Mobile balance top-up • Taxi ordering • Hotel booking
Currency Supported	18	At least 9 major currencies
Transaction Charges	0.1% per transaction (US $2,817) passed limit	0.1% per transaction (US $153) passed limit

Table 3. Comparing KuulPay to Alipay and WeChat

	KuulPay
Devices Supported	Android smart phones and all devices with a web browser (Computers & Mobile)
Financial Management option	• Money transfer • Bill payment

	• E-commerce payments • Fund raising
Currencies Supported	1 (Ghana Cedis)
Transaction charges	• Free money transfer • 4% charges for merchants when MTN Mobile Money payment is use by the buyer or 2% charges for merchant when user pays from his KuulPay account. No charges for a buyer. Only the merchants pay charges. • 1% charges for withdrawal of cash at merchant's shop (20% of the 1% charge for the merchant as commission and 80% of the 1% for KuulPay

Three main financial services worth noting from both Alipay and WeChat Pay that KuulPay can include in the financial management option in the future version of the application. In order to increase the user base of the application, KuulPay will develop a ticketing platform on KuulPay for cinemas, sports stadiums, event organizers to sell tickets to KuulPay users. Once a KuulPay user buys the ticket, a unique serial number and pin will be sent to their phone which they can use as a passage.

KuulPay will also develop hotel reservation, school management and other useful applications with the payment system integrated for the Ghanaian market. This will force the users of these services to accept the payment system.

4.4.3.2. Paypal and Skrill

The two mighty online payments are Paypal and Skrill. Despite their size, many online businesses are avoiding their payment solutions due to the following reasons:

- Cost
- Tendency to lock accounts / Difficult time getting it unlocked
- Low customer service/support
- No rewards for loyalty or leaving money laying dormant in the account

Pros and Cons

Table 4. Comparing Skrill to Paypal

	Skrill	**Paypal**
Allowable account per customer	1	2
Charges for	Sending money	Receiving money
Deposit fee	From 0% to 7%	Free
Merchant transaction fee	2.99% (+ fixed amount)	4.5% (+ fixed amount)
Dormant account fee	€1 per month after 12 months	Free
Merchant acceptance	Few merchants accept payment through Skrill	Widely accepted but not universally
MasterCard Debit Card offered	All customers	Only US customers

Table 5. Comparing KuulPay to Skrill and Paypal

	KuulPay
Allowable account per customer	1 per mobile phone number
Charges for	Receiving money (Sending is free)
Deposit fee	3% if MTN Mobile Money is used / Free for scratch cards

Merchant transaction fee	2% when buyer uses KuulPay account but 4% when buyer chooses MTN Mobile Money option. KuulPay pays MTN Mobile Money 3% on every transaction on their payment platform
Dormant account fee	Free
Merchant acceptance	Yet to launch
MasterCard Debit Card offered	Nice to have when customer base grow so customers can withdraw cash from ATM Machines

From the above information about Skrill and Paypal, it is very important for KuulPay to have good customer service/support to resolve issues such as lock of accounts. As the company grows, it will also be of advantage to give interest on money which has been left dormant in the account just as the banks do. The cost should also be moderate so that many merchants can join the platform. In the near future when the partnership between MTN Mobile Money and KuulPay grows, hopefully their percentage charges may drop so that merchant pay less for buyers who uses the MTN Mobile Money as payments on the KuulPay platform.

5. CONCLUSION AND FUTURE WORK

The major mobile wallet operators in Ghana are the telecommunication operators (MTN Mobile Money by MTN, Airtel Money by Airtel, Vodafone Cash by Vodafone and Tigo cash by Tigo). Even though some banks have mobile applications for managing one's account, these four major telecommunication networks are the major mobile wallet operators in Ghana and MTN Mobile Money having the majority of the customers.

In the literature review, it is revealed that one of the major reasons why some mobile wallet have failed is due to lack of partnership with other businesses who either they can depend on or have mutual benefits. From this knowledge, it is clear that for KuulPay to strive in Ghana, it is necessary to partner with at least one of the major existing mobile wallet operators in Ghana. Since MTN Mobile Money has the major share of customers, it is therefore important to partner with them. KuulPay therefore integrated their payment system into KuulPay so people can use their network to pay while being on the KuulPay payment platform. Even though MTN Mobile Money charges some percentage on every transaction, it is necessary to partner with them so that KuulPay can serve lots of people in Ghana. Even though the KuulPay scratch cards would be made to be available for topping up of one's account for payment, others who are already MTN Mobile Money customers would prefer to use that platform to make payment on the KuulPay platform.

In the literature review, it is revealed that for M-wallet to break through, the application must be useful to the customers and less expensive. It is also revealed that the developers of the application must involve the key customers in the developmental phases. In the discussions with key merchants who wishes to have online shop, it became necessary to develop an online shop which has the KuulPay payment portal already integrated so that customers will only need to manage the website. This is taken into consideration and KuulShop is developed so people of all walks of life can easily manage online shops and accept payment through KuulPay.

In the literature review, it is revealed that awareness needs to be given to the potential customers of the M-wallet to know that such application exist and its usefulness to them. It is therefore necessary to budget for marketing the KuulPay product when it is pilot and large scale launched to create the awareness. The marketing can be done on school campuses, one on one campaign to potential merchants (Online shop merchants and merchants who will serve as withdrawal points) and on a number of popular websites, radio and television stations.

Other M-wallet such as Apple Pay and others state of the art solutions were analyzed and the one that KuulPay integrates into the system was the Multifactor / Two Factor Authentication to make the system more secure to prevent people from transacting businesses without the account owner's awareness. The two factor authentication ensures that the owner of the account has a token aside the username and password to authenticate himself during financial transactions. Even if a cyber thief manages to login into another person's account, he won't be able to make payments since he won't have access to the token (code) sent to the phone of the account owner. It is therefore necessary that account owners secure their phones.

The contactless payment feature using NFC (Near Field Communication) will be considered in the second version of the mobile wallet. This will enable customers to make payment at terminals who accept the KuulPay payment system.

Pilot launching is conducted as "trials" to see the reactions and patronage of the product before the full launching. KuulPay will pilot launch the product in the month of February, 2018 with the marketing of the KuulShop application and the fund raising feature of KuulPay. This pilot launching will assist KuulPay to test the market and also have ample time to plan for the full launch. A number of adverts will be run on some popular websites in Ghana as well as social networks to publicise the Online shop feature. The online shops who are merchants of KuulPay will then sell the KuulPay scratch cards in their shops for new KuulPay users to sign up and top up their account so they can make future orders online.

The fund raising feature will motivate owners of the project to publicize their projects which in turns, publicize KuulPay. Fund raisers might share their projects on their social network pages for friends to contribute for their project. This will create the awareness of KuulPay before the actual full launching of the product.

In the course of the pilot launching, KuulPay will be developing the ticketing platform for cinemas, football teams, event organizers etc and other applications which has the KuulPay. The Kuulchat social network will also be rebranded to focus on both social network and e-commerce platform for students to sell and buy e-books. These feature will be available before the full scale launching of the KuulPay payment portal. The full scale launching will be in autumn academic year (August,2018) when universities and senior high schools are starting new academic year and would need new text books for their studies and the ticketing platform and hotel reservation application product are ready to be launched as services provided by KuulPay.

M-wallet will have massive impart on day to day activities of Ghanaians and even reduce the current traffic situation as one need not travel to a long distance to purchase an item which he can buy with just a click of a mouse and be delivered to his door step. Since many of the youths have access to smart phones and tablet, the possibility to pay online will pave the way for textbook publishers to also sell electronic version of their books online, reducing the cutting down of trees for paper manufacturing and paper waste in the country.

Once the KuulPay application is launched, it is the desire to create more platforms with the KuulPay payment portal integrated that will benefit many Ghanaians. Parents will be able to pay their wards school fees without physically going to the school premises to make payment. With just a click of 'Pay with KuulPay' button, the fees should be paid and the school notified.

The M-wallet has bright future in Ghana but more awareness needs to be created and the usefulness of the M-wallet also demonstrated to the Ghanaian community.

Future Research Suggestions

1. What are the marketing strategies for m-wallets in developing countries (Ghana as a case study). This research will help market m-wallet launched to survive in the Ghanaian market.
2. Mobile Payment Adoption in Developing Countries (Ghana as a case study) - Quantitative Analysis. This research will help to see how Ghanaians are adopting to the m-wallet as compared to the normal transaction of businesses with the physical cash.

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