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Mobile based application for sharing building and construction information: a case of Nairobi County

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MOBILE BASED APPLICATION FOR SHARING BUILDING AND CONSTRUCTION INFORMATION: A CASE OF NAIROBI COUNTY

By

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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23/06/2017

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ABSTRACT

Owning a dream home is one of the key achievements every person wishes to meet in their lifetime. However, this desire faces a lot of challenges as the house prices rise steeply locking out the middle income earners in the country. This results in many people preferring to build their own houses at their own pace due to budget constraints rather than buying a complete built house. Generally, there is a housing deficit in the urban areas due to the increase in the population and urbanization growth rates. Due to the housing deficit, a lot of house contractors have emerged and some unprofessional contractors are exploiting the prospective house owners by offering poor services at high prices. There is lack of information on the available credible contractors who are near the location of the client thus unsuspecting clients engage some rogue and incompetent contractors who build substandard houses which leads to consequential failures such as collapse of the building, loss of resource and lives.

This study aimed at creating a mobile application which offers location aware services by displaying a pool of experienced and genuine contractors and informal builders on a Google map. The clients are able to locate these service providers closer to their location and the application facilitates the interaction. The application also provides information on the various approved Appropriate Building Materials and Technologies (ABMT) which help the client to make an informed choice during a house construction.

The study adopted the evolutionary prototyping methodology to create the mobile application. This allowed the system to be developed in increments that were readily modifiable according to the user feedback. Later, the study engaged in system testing and validation to ensure the application was working according to the set requirements. Among the tests carried out were: Acceptance, Usability, Speed tests, Functional, Load and Integration tests.

Keywords: Housing, Construction, Contractors, Informal Builders, Location Based Services, Android

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LIST OF ABBREVIATIONS

ABMT	- Appropriate Building Materials and Technologies
API	-Application Programming Interface
CBK	-Central Bank of Kenya
DFD	- Data Flow Diagram
EPS	-Expanded Polystyrene Panels
GDP	-Gross Domestic Product
GPS	- Global Positioning System
HFHK	- Habitat for Humanity Kenya
ICT	- Information and Communications Technology
KBA-HPI	- Kenya Bankers Association-Housing Property Index
NGO	-Non Governmental Organizations
UML	-Unified Modelling Language

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DEDICATION

I dedicate this proposal to God for His knowledge and tranquillity, my family for the support and encouragement, to all my classmates for the support they granted me throughout the master's course, the Safaricom Academy lecturers for their devotion and guidance and finally, to my supervisor, Dr Humphrey Njogu for his advice throughout the research period.

DEFINITION OF TERMS

Building:	The art of assembling materials into a structure (Oxford Dictionary, 2014)
Construction:	The work of building or making something; especially buildings (Oxford Dictionary, 2014)
Contractor:	A contractor is a group or a person who is in-charge of the construction, building, renovation or demolition of a building, road or structure (Building Kenya, 2014).
Feasibility Study:	A study that shows if something can be done (Ujenzi Today, 2012)
Housing:	Dwellings provided for people (Merriam-webster, 2015)
Informal Builder:	One who engages in construction as a means of livelihood but has limited professional skills, low productivity and low capital investment (Results for Development Institute, 2012)

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The housing and property industry has been on the spotlight in the recent years. This is due to the notable house price increase. In Kenya the sector seem to boom from the mid to the late 2000's as it responds to demand created by expanding middle class families. This also has enhanced the state economy as more tax is generated from property rates in building and construction as well as rental payments (Mbae N, 2011).

Hass Consulting Limited (2016) indicated that recent capping of interest rates following the amendments of the Banking Act 2016 would also spur more investment in housing industry. The capping would have a twin effect; it would make credit more affordable to the developers hence in return reduce the cost of units coming up in the market; this also would make potential borrowers to take up mortgages and other loan facilities.

Kenya's real Gross Domestic Product (GDP) is estimated to have maintained its growth momentum at 5.8% in 2016 compared to 5.7% in 2015. However, the building and construction sector registered a slower growth of 9.2% in 2016 compared to 13.9% in 2015 (Kenya Bureau of Statistics, 2017). This led to the increase in the property prices. According to the Hass Property Index, the house prices increased by 1.2 % in the third quarter of 2016. Apartments recorded the highest increase in the asking rent by 1.7%.

Kenya's annual population growth rate is at 2.6% as at the year 2015 (World Bank Data, 2016) . Also, its urbanization rate is recorded to be 25.6%. This explosive growth overwhelms the housing infrastructure in the capital city, Nairobi. The population increase placed a surge on the number of housing units that are developed annually to offer accommodation. Due to this, there is a proliferation of slum structures accounting to 60% of the population (Habitat , 2016). According to a report by Center of Affordable Housing Finance in Africa, the estimated annual housing requirement in Kenya is about 132,000 housing units. However there is a production of 50,000 units leaving a recurrent accumulative annual deficit of 82,000 units (Housing Finance Africa, 2016) .This creates a housing challenge in Kenya. As a result, there is increased growth of slums which stymie economic development.

There is lack of information on the available credible contractors who are near the location of the client. Due to lack of this information many unsuspecting house owners setting up new houses have contracted rogue and unqualified contractors leading to cases of building failures and consequent collapsing of structures reaching an alarming rate in the past years. This has led to loss of property, resources and lives (Construction Kenya, 2015).

There have been existing sources of building and construction information from various online sources and building and construction magazines. However, much of this information online is not well documented to offer advice to the majority Kenyan population in regards to the construction budgets of the majority of middle class income earners. One major source of information is the National Housing Corporation (NHC), a state owned corporation whose role is to provide and facilitate access to innovative housing solutions in Kenya. However the website misses a lot of information in regards to housing construction techniques and the use of Appropriate Building Materials and Technologies (ABMT).

The aim of this study was to create a mobile application which offers location aware services by showing a pool of experienced and genuine contractors and informal builders closer to the client. This would help the client in reduction of cost in the budget in terms of the materials supplied and the labour force. The application also facilitates the interaction between the client and the service providers. Through this interaction, the client has a chance to go through the options available and make an informed decision. The application also provides information to the client on the various approved ABMTs which would help them reduce the building costs.

In Kenya's Vision 2030 and ICT Master Plan, the underlying strategy is to transform Kenya into the foremost knowledge economy on the African continent; to leverage ICT to improve delivery of service; expand employment and entrepreneurship opportunities; and enrich citizen’s participation in governance. Science, Technology and Innovation (STI) support this underlying strategy (Government of Kenya, 2007). This research was tailored towards achieving the Vision 2030. From the solution, we created a strong base for enhanced efficiency, and promoted a value add on the building and construction industry.

1.2 Problem Statement

Home owners are often not aware of contractors or informal builders within their locality who they can engage while doing their construction projects. This may increase the cost of construction as materials and labour is accessed away from the location. Some clients end up in the hands of rogue contractors leading to cases of building failures and consequent collapsing of structures. The informal builders who have vast experience in the construction industry might be next door but are not much visible to the clients.

Based on the aforementioned deficiencies in building and construction, this study proposed a solution that would offer location aware construction information; a pool of various competent contractors and informal builders be displayed on a Google Map. The solution would also inform on the various new technologies in construction to enable the prospective builders make an informed choice during their construction project.

1.3 Research Objectives

i. To review the sources of information on labour and materials used while constructing a house
ii. To analyse the existing solutions for providing house construction information
iii. To design, develop and test a location aware mobile-based system which provides information on labour and building materials during a house construction
iv. To validate the functionality of the mobile-based application with prospective home owners

1.4 Research Questions

i. What are the common sources of information on labor and materials while constructing a house?
ii. What are the research gaps of the existing solutions?
iii. How can a mobile application that will provide location aware information on labor and materials while doing a house construction be designed, developed and tested?
iv. Does the location aware mobile-based system fill in any gap in relaying building and construction information to prospective home owners?

1.5 Justification of the Research

Home ownership has been left to the hands of the wealthy few due to the high prices of property which locks out the majority middle-class home buyers (Business Daily, 2014). To mitigate on the situation, majority of the middle-class home owners have resorted to buying land and building their own homes. However, due to lack of information on the right contractors or informal builders to engage with, they spend much on their budget sourcing the resources away from the site. Some unfortunately contract rogue contractors who use substandard materials for house constructions resulting to collapse in the long run.

Therefore there was a need to come up with a mobile application which would leverage on the current smartphone proliferation and offer location aware data of all contractors and informal builders who have the expertise in building a house and are located within the reach of the client in a given location. The mobile application will also offer information on the various safe construction techniques leveraging on the new technology. This solution will enable the client reduce on the cost of construction by sourcing resources locally. The application will offer client information on latest building technologies which will enable the client make the right decision during a construction project.

1.6 Scope

This research was conducted within Nairobi with a primary focus on building works contractors in Nairobi County. The mobile solution was built on Google Android platform targeting users of the smart phones with internet connection. The research focused on offering easy accessibility of contractors and informal builders and information on the approved building and construction technologies. The solution is targeted for prospective home owners who want to build houses.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The section discusses the Kenyan population index and effects of urbanization in owning a house in the urban areas. It further takes a look at the housing index and affordability. The section also discusses the process involved in putting up a house and various sources of information while building a house in Kenya. Also, the chapter goes ahead to discuss the new technologies adopted in house constructions. The last section discusses some of the existing solutions enhancing house constructions and highlights on the research gap; the study also describes the conceptual framework of the proposed solution.

2.2 Housing and Construction Statistics and Growth

2.2.1 Population Index and Urbanization

Kenya's annual population growth rate is at 2.6% as at the year 2015. Also its urbanization rate is recorded to be at a rate of 25.6% (World Bank Data, 2016). The population increase places a surge on the number of housing units that are developed annually to offer accommodation. Due to this, there is a proliferation of slums structures accounting to 60% of the population (Habitat , 2016). The figure 2.1 below indicates the urban population in percentage in various African countries and Kenya is almost 30%.

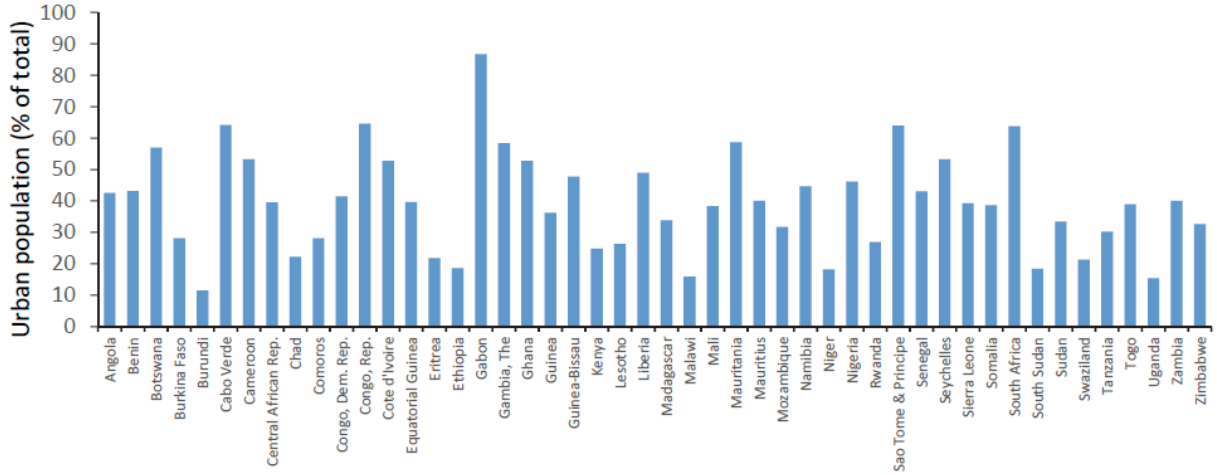

Figure 2.1 Urban Population in Percentage in Various African Countries- Adopted from (The World Bank, 2015)

According to a report by Center of Affordable Housing Finance in Africa, the estimated annual housing requirement in Kenya is about 132,000 housing units. However, there is a production of 50,000 units leaving a recurrent accumulative annual deficit of 82,000 units (Housing Finance Africa, 2016). This creates a housing challenge in Kenya. As a result, there is increased growth of slums which stymie economic development. The slum dwellings bring high risks of disease infections and high rise of insecurity thus making decent housing a major priority.

2.2.2 The Housing Index

According to Hass Property Index, the property prices increased by 1.2 % in the third quarter of 2016. Apartments recorded the highest increase in the asking rent by 1.7% (Hass Consult Ltd, 2016). On the other hand, the Kenya Bankers Association-Housing Property Index (KBA-HPI) noted a 2.2 percent rise compared to the previous quarter. Also there was a taste consistency as buyers searched for secured neighborhoods with adequate amenities (Kenya Bankers Associattion, 2016). The figure 2.2 shows the house price rates variance over time showing a rise on prices on the Q3 of year 2016 which was at 2.2 %.

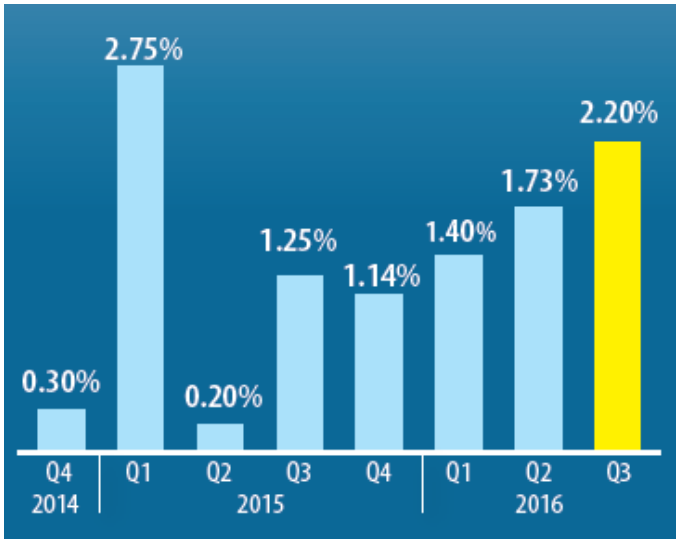

Figure 2.2 The Overall Pricing Change in Percentage- Adopted from (Kenya Bankers Associattion, 2016)

The table 2.1 shows the number of private buildings as reported by Nairobi City County and public buildings across the country. The total number of private buildings reported an increase of 12.6 percent to 8,468 as of year 2015 while the residential building accounting to 87.8 percent of the completed private buildings.

Table 2.1 Reported Number of Completions of New Private and Public Buildings- adopted from (Kenya National Bureau of Statistics, 2016)

	Private (Nairobi City County)			Public (Nationwide)		
Year	Residential	Non- Residential	Total	Residential	Non- Residential	Total
2011	4,512	505	**5,017**	587	-	**587**
2012	4,824	637	**5,461**	2,015	20	**2,035**
2013	5,447	876	**6,323**	376	-	**376**
2014	6,538	985	**7,523**	243	-	**243**
2015*	7,434	1,034	**8,468**	45	-	**45**

According to the Kenya Vision 2030 social pillar (2012), under the housing and urbanization sector, there are some flagship projects that are set in place to improve the housing sector in Kenya. Among them includes establishing Housing Technology Centers in each constituency in the aim of increasing access to decent housing by promoting location-specific materials and low cost housing thus enhancing affordability. The other flagship project is producing 200,000 units annually under the private public partnerships and other initiatives. However this number has not been met because only over 800 urban housing units have been developed while 857 units are ongoing at various implementation levels.

2.2.3 Access to Finance

Access to finance to facilitate buying a house has been the major challenge to the majority middle class income earners. The high mortgage rates lock out many who cannot qualify for the loans. The recent amendment of the Banking Act 2016 which capped the high interest rates charged by banks would make credit more affordable (Hass Consult Ltd, 2016).

From a residential mortgage survey done by Central Bank of Kenya (CBK) on 31st December 2015, it was noted that the value of mortgage loans assets increased to Ksh.203.3 billion in December 2015 from Ksh. 164.0 billion in December 2014. This was a 23 percent growth attributed to the appetite for home ownership. Also the mortgage loan size increased from Ksh 7.5 million to Ksh. 8.3 million due to increased property prices (CBK, 2015).

2.2.4 Affordability

Despite the availability of financing models, the high cost of houses and property, the high mortgage rates and the low income earned by the majority middle class population, among many other factors inhibits the growth of Kenyans home ownership. Table 2.2 below showcases the various mortgage market impediments to acquiring a mortgage loan from a survey conducted by CBK.

Table 2.2 Residential Mortgage Market Survey –December 2015, adopted from (CBK, 2015)

Mortgage Market Obstacles	Frequency of Response
High Cost of Housing/Properties	31
High Interest Rate	26
High Incidental Costs(Legal fees, valuation fees, stamp duty)	25
Low level of Income	24
Difficulties with property registration	22
Stringent land laws	12
Access to long term finance	7
High Cost building/Construction	15
Lengthy change process timelines	7
Start-up Cost	7
Credit risk	4

From the table 2.2 high cost of housing, high interest rates, high rates of legal fees and low levels of income are the major impediments to acquiring a mortgage plan. Despite the same, the mortgage market is expected to grow supported by increased demand for low cost houses, expanding middle class, improved infrastructure and increasing house development in the peri-urban areas (CBK, 2015).

However these mortgage market rates do not favor the majority of the middle class population. According to the Kenya National Bureau of Statistics (KNBS), Kenya's middle class includes anybody spending between Sh23, 670 and Sh199, 999 monthly. From the various housing index reports, houses and property have sustained an upward trajectory. According to the Hass Property Index, the value of property has gone from 7.1 million in December 2000 to 31.5 million in September 2016. The average value of a 4-6 bedroom property is currently 48.3

million while the average price of a 1-3 bedroom property is 14 million (Hass Consult Ltd, 2016) This is illustrated on the figure 2.3.

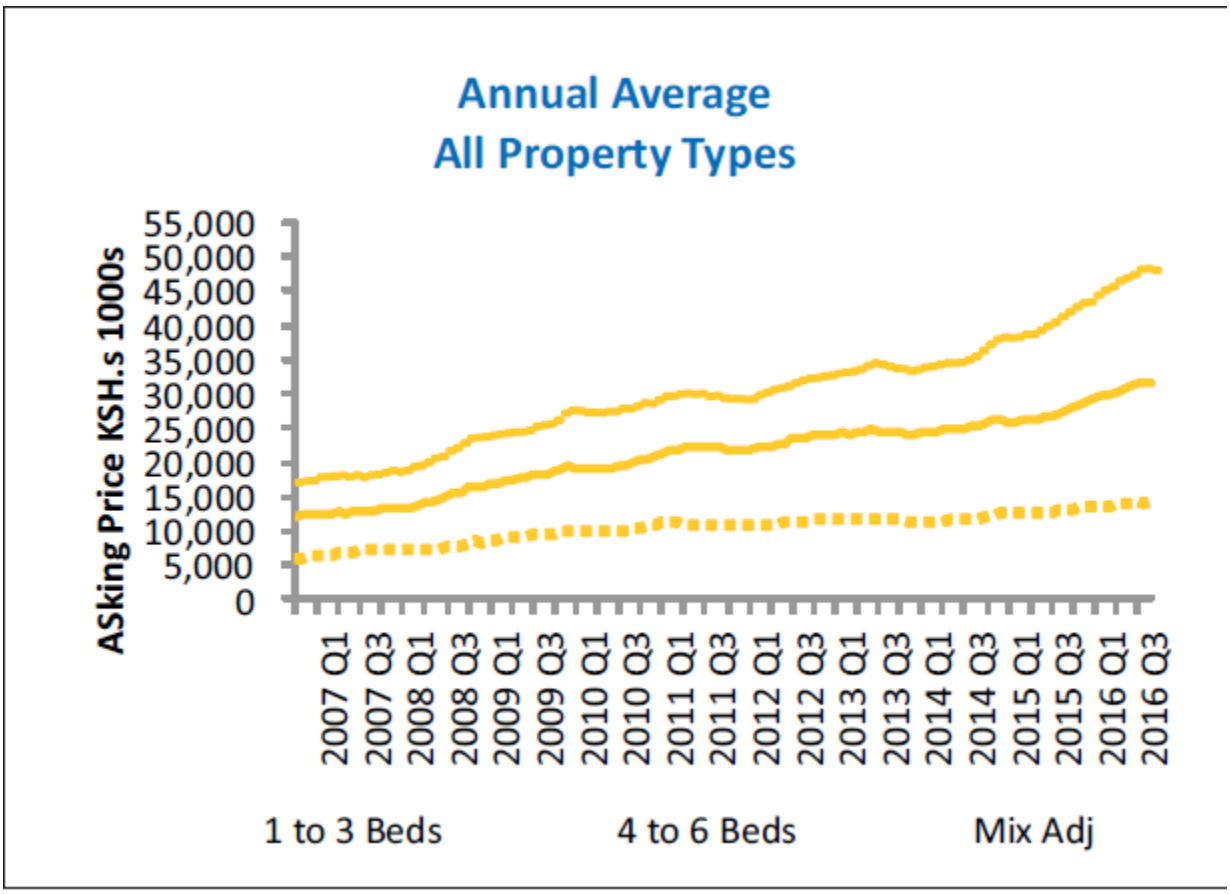

Figure 2.3 Annual Price Changes of Various Property Types –Adopted from (Hass Consult Ltd, 2016)

From the above prices, it's evident that majority of Kenyans cannot afford to own such property. Prospective buyers for a 1-3 bedroom property would need to qualify for a 14 million mortgage loan at the current 14.5 percent interest rate. This suggests that this buyers would be required to pay Ksh. 179,199.69 per month for a period of 20 years (HF Group (Formerly Housing Finance Company of Kenya), 2016). To make such a move, the monthly income of the prospective buyer should be Ksh 300,000 or above. This indeed poses the challenge; affordability issues from the larger middle income population whose income is low. To mitigate the challenge, majority of the home owners prefer to build their own houses at their own pace due to the budget constraints.

2.3 Building a House

It is everyone's dream to own a house in their lifetime. Majority of the middle income population prefer constructing their own house through a developer or the informal builders with vast experience and great portfolios. This is due to having a constrained budget when it comes to construction costs. This research was able to establish a few major steps considered while putting up a new house for a family;

The first step involves doing a feasibility study. This is a controlled research of identifying a problem or strength in a given venture. In this case, you need to identify a suitable piece of land to set up a new house. In the study you need to identify the historical background of the land in question. Conflicting information raises an alarm about the piece of land. If the land has conflicting information, it should not be bought, same as any land found to be public.

The feasibility research also helps you to identify the type of soil on the land in question. Some soil types such as cotton soil are expensive while laying a foundation of the house. The study also helps you identify the local by-laws governing the area. Some areas have controlled development. You will also be able to identify the local amenities such as the availability of a local authority sewer line. This initial study helps you to get the overview of all the amenities available around your choice of land, the availability and cost of building materials and the charges of labor (Ujenzi Today, 2012).

Having done a successful feasibility study and bought the land, the next step is to put your dream home on paper. This involves first sketching a rough design of your dream home that suite your budget. Then identify an experienced architect who will help you put the sketch unto an organized format which is viable. The design should fit your budget and lifestyle. Having done the architectural design, you need to consult a structural engineer who is qualified and experienced in designing and planning of structural details. The structural engineer puts into consideration the safety, function and comfort of occupants. The engineer advices on the class of concrete to be used in each area, the kind and size of iron beams to be used among other things. At this point if all the drawings are in order, they are taken to the local authorities for approval (Construction Kenya, 2015).

While putting up the house, the client involves service engineers. These are electrical and the water engineers. For a small project the trained and experienced plumbers and electricians are fit

for the task. They are responsible for the design, installation, operation and maintenance of electrical, plumbing systems in the building. The client may also involve a quantity surveyor who is responsible for estimating the costing of the whole construction project. The prospective home owner may contract a developer to do the whole project on his/her behalf or sign a labor only contract with a skilled and experienced informal builder to undertake the construction of the project. This all depends on the budget constraints (Kenya Homes Guide, 2016).

There are various challenges associated with a house construction project. Some of them include: Rogue contractors who are driven by greed and are constructing substandard buildings that are extremely unfit for human living. This thus leads to consequential collapse and loss of resources and lives. Secondly, capital is a major factor hindering growth in the construction industry. Most contractors have placed high rates for constructing simple homes. This hinders many middle class populations from building a house (Construction Review, 2016).

Due to arrival of new technologies in the market, we have few qualified professionals with the skills set required. Most of the professionals have a conservative perspective and thus prefer clients whose thinking resembles theirs. This makes adopting the new technologies in housing a challenge (Inclusive Business Hub, 2016). Due to lack of professionals there is poor quality assurance which results in substandard building collapsing. Some of the quality assurance providers offer a poor service through poor documentation and poor decision making (Libonga, 2015).

All the above challenges are caused due to lack of information, many prospective house builders end up making the wrong decisions. This in turn leads to loss of resources and a times failure of the construction project (Muir, 2005).

2.4 Information on Construction

In Kenya's Vision 2030 and ICT Master Plan, the underlying strategy is to transform Kenya into the foremost knowledge economy on the African continent; to leverage ICT to improve delivery of service; expand employment and entrepreneurship opportunities; and enrich citizen’s participation in governance. Science, Technology and Innovation (STI) support this underlying strategy (Government of Kenya, 2007). According to Peter Drucker (1998), there have been great transformations from the industrial economy to the knowledge economy. Today the most important factor of production is knowledge. If there is adequate knowledge in house

construction market, there could be an increase in quality development as well as promote safety in the houses built.

As a prospective house owner starts any house building project, they gather information which forms the basis of their feasibility study. However this is a challenge to many as to get the right sources to engage with is a problem. Some developers driven by greed and the love of money engage offering poor consultation services (Africa Review, 2016).

Lack of knowledge of the local ground conditions leads to consequential loss of resources and lives. Natural catastrophe perils such as flash floods have been experienced in some major estates within Nairobi County. Construction companies would minimize such risks by developing better flood mapping tools and increase the awareness on how to protect from flash flooding (Hardwicke, 2015).

There are various common sources of information while building a house, majority of the middle income earners engage the people close to them who may have built a house before to get more information on the sources of the right contractor or even the informal builders. Some of the sources include (Kenya Homes Guide, 2016) ; Referrals from close friends and relatives. Through this model, majority of clients seek house construction information from relatives, close friends and colleagues who have constructed before. This is all based on trust and relationships. However this is not a reliable source of house construction information (Construction Kenya, 2015). Other prospective home owners seek information from construction websites. A lot of websites have been set up to document house constructions steps and tricks for trade. This acts as a resource center for all participants in the building industry (Ujenzi Today, 2012).

Eventually social media took over the space being one of the key drivers of digital disruption. With the proliferation of smart phones, social sites such as Facebook have groups where participants showcase their portfolios and discuss house construction. From the forums a client can reach out to the interested contactor or supplier of materials. The major challenge from these sources of information is getting credible information (Facebook, 2015).

2.5 Technology and Housing

The Kenyan government is banking on Appropriate Building Materials and Technologies (ABMT) to lower the building costs. These technologies are safe, cost effective, innovative, and

acceptable to the climatic and social economic conditions of an area (Construction Kenya, 2014).Some of the ABMTs adopted include: Expanded Polystyrene Panels (EPS), Interlocking bricks, Container houses among others.

2.5.1 Expanded Polystyrene Panels (EPS)

EPS is popularly known as prefabricated building technology. This technology is addressing the house shortage in Kenya by reducing the time frame to build a house and cutting the construction costs. These are panels that consist of undulated (wave shaped) polystyrene covered both sides with zinc coated square mesh. The panels are assembled onsite then in situ concrete is poured for reinforcement. This technology has been implemented on other countries such as Mexico, USA, Nigeria, and Mozambique just to mention a few. Kenya National Housing Corporation (NHC) has set up a plant for the production of EPS panels in the country. This is due to the rise on demand of home ownership and the rise of prices of the houses built by conventional materials such stones and mortar. The EPS panels are considered the best in terms of affordability, availability, safety and security in terms of speed in construction (National Housing Corporation, 2016).

The advantages of EPS are that they have energy saving characteristics. EPS contains 98 percent air and thus can be used as a thermal insulator. They have high load bearing capacity at low weight, they have sound insulation, and they are earthquake resistant having a water and vapor barrier. Other advantages are that they are durable, fireproof, and recyclable and have low maintenance (Andrew, B, 2017), (EPSASA, 2016).

2.5.2 Interlocking Bricks

They are also referred to as *hydrafoam* bricks. These are bricks that are made from machines using hydraulic high pressure to press a mixture of soil/ fly ash with sand and cement into a hard brick. The interlocking building block technology eliminates the use of mortar in 70 % of the building structure with no need for concrete and steel columns. (hydraform, 2016) The technology which is imported from South Africa is able to cut the cost of housing by 35 percent because of the bricks strength and no plastering is used. This technology is part of the Appropriate Building Materials and Technologies (ABMT) the government is banking on to lower the construction cost and to improve the quality and speed of construction (National Cooperative Housing Union, 2016).

2.5.3 Container Houses

Shipping containers can be modified to virtually fit any use. One of the uses would be their modification to a house. Good internal and external finishing is done in a container to make it habitable. Plumbing and electrical system is fitted in the container. An example is container home is from Eco Homes Limited; customized units come fitted with toiletries and sanitation, they are insulated and secured (Eco Homes Limited, 2016).

The cost of one bedroom self-contained house ranges from Ksh 450,000- Ksh 700,000 while a two bedroom ranges Ksh 650,000 to Ksh 900,000 depending on the finishing, modifications and other contingences such us transport. The modification would not take more than two months. This budget favors the majority of the middle income earners (Standard Digital, 2016).The container houses would play a big role on eliminating slums settlement. The container housing concept has been adopted in South Africa where the housing backlog is estimated to be 2.3 Million. A Cape Town based company; Berman Kalil Housing Concepts modifies the decommissioned shipping containers to low cost homes (Berman Kalil Housing Concepts, 2016).

In Kenya, the same innovation is being implemented by many construction companies thus creating affordable low cost homes, creating employment to our local youth, fast to be build eco-friendly homes. The figure 2.4 shows a house created by modifying a container.

Figure 2.4 A House Created by Modifying a Container (Eco Homes Limited, 2016)

2.5.4 Pros and Cons of ABMTs

These technologies enhance green building because the methods used are regarded as eco-friendly building techniques with low embodied energy that are cost effective- most of them used from recycled materials thus ease pressure on our ecosystem. They take a short time to construct because parts of the most prefab homes are already made; all that is required is to assemble the parts on site. They enhance a cost effective mode of construction which makes the construction budget much lower than the standard methods. Quality control is easy because much of the materials are checked on the factory assembly line (Construction Kenya, 2014).

However ABMTs have a few cons including: they require skilled labor force to construct but we have a few people in the market who have the skills on prefab housing. Transportation costs a times are expensive; they too require heavy machinery to move the materials efficiently. They are difficult to redesign once the fabrication is done. Thus due to the speed of construction, changes would disrupt the flow and the timing of the project thus difficult when a change is done at the late stage of the project (Construction Review, 2016), (Andrew, B, 2017).

2.6 Existing Initiatives Promoting Information Sharing in House Construction

There are various initiatives in the country engaging in offering vital information in house construction. Some of these initiatives include:

2.6.1 Builders of Hope Kenya with iBuildApp

Builders of Hope Kenya have a mission to increase the availability of affordable high-quality and safe housing options. They create a virtual marketplace in the iBuild App; connecting the potential consumers with architects; financial firms, construction authority and builders. The challenge with iBuild application is that it is not enhanced to offer location aware services such as finding contractors or informal builders near a given location. The application does not offer information on the ABMT to help clients reduce on the construction cost (Builders of Hope, 2016).

2.6.2 Habitat for Humanity Kenya (HFHK)

This organization began in 1982 and it helps communities build their homes in Kenya. So far it has assisted over 19,000 families across the country. HFHK now provides housing microfinance, advocacy, market development, community development and volunteer engagement. One of their latest projects is building affordable housing to the elderly using a technology that provides

low-cost, energy efficient and sturdy for a long time houses. They train the local communities on ABMT building techniques in the various areas of the country. Though a great initiative, it does not have the ability to render its services to all of the informal settlement in the urban areas which is estimated to be 60% of the population (Habitat for Humanity Kenya, 2016).

2.6.3 Construction Blogs: A Case of Ujenzi Today Construction Blog

There are several blogs which offer information on construction and home ownership journey. Among them is the Ujenzi today construction blog. This is a construction blog that offers information on building a new house, the tricks of trade to build it as economically as you can within your project budget. Their mission is to eliminate ignorance in the construction industry. Their challenge is that they don't offer any leads to the right construction experts to engage while handling a project and the information offered on the website is not verified. They do not have a mobile application as well which would enhance the ease of access to information (Ujenzi Today, 2012).

2.6.4 Facebook Groups: Builders & Co-Creators

There are many social forums for house building and construction in social media. An example is Builders & co-creators, which is a group on Facebook that offers information on the house construction. On the forum, clients who plan to engage in a house construction project ask questions and a discussion thread streams from various people. Contractors and suppliers also showcase their work for marketing purposes. One major challenge on this is that being a social media page; many would take advantage and offer incorrect information, conmen would impose as real contractors leading to defraud unsuspecting clients (Facebook, 2015).

2.7 Conceptual Framework

The mobile application has different components; the mobile front end user interface and a web backend. All data is stored in the cloud. The users make queries from the application. There are assigned agents on the backend who populate the categories and portfolios of each category.

A client who wants to engage in a house construction has to sign into the mobile application and clicks on view contractors or informal builders. The application loads a Google Map with marker points on where these service providers are located. The client may zoom in to the location interested and view the nearby service providers. The client can click on the marker of the service provider of choice to view more details and also interact with the service provider. The

figure 2.5 shows the conceptual framework where the user is able to request construction information or contractors and informal builders on the current location. These queries are processed on the data store on cloud and the user receives an immediate feedback. The administrator on the other hand adds information about the contractors and the informal builders.

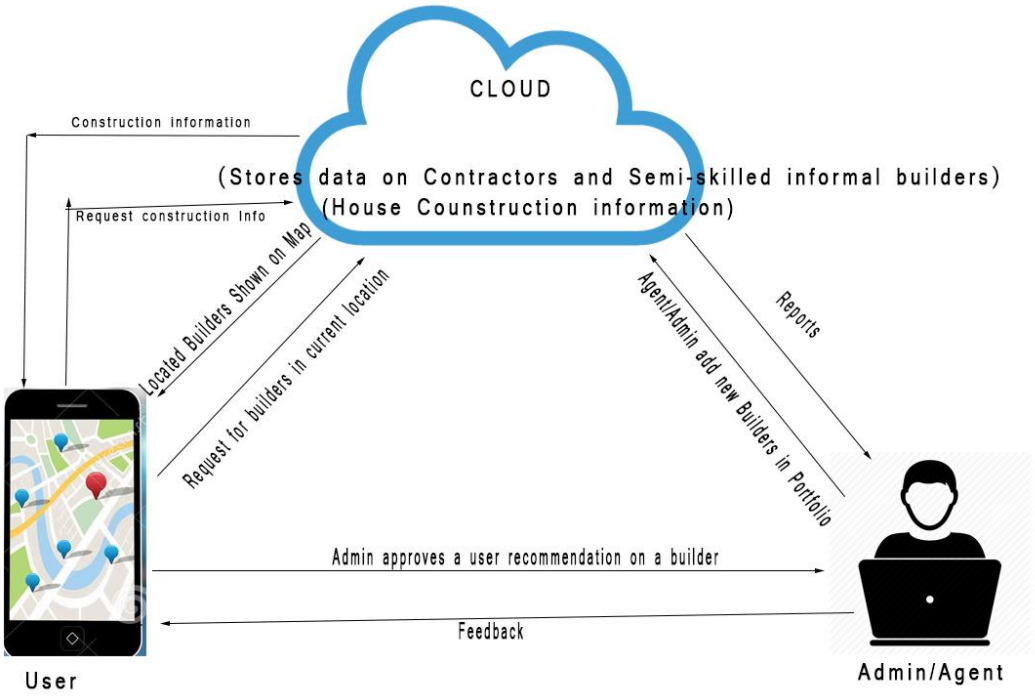

Figure 2.5 Conceptual Framework

2.8 Conclusions

From the current initiatives, it is evident that we do not have a mobile solution to offer key location aware information on construction and be a market hub of skills set in the house construction industry in the country. A mobile solution which displays a pool of genuine contractors and informal builders with proven portfolios around a given location of the client and also offers updates on the ABMTs would enhance access to construction information. This will in turn help the prospective house builders to make an informed choice before undertaking any construction project.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the methodology that was applied to enable the development of the proposed solution. It discusses the activities undertaken on each phase of the application development life cycle.

3.2 Evolutionary Prototyping Methodology

This research engaged the evolutionary prototyping methodology to create the mobile application. This methodology enabled the application to be developed in increments that were readily modifiable according to the user feedback. Evolutionary prototypying model is ideal for requirement analysis since there is no existing system from which requirements can be drawn from. The prototypying methodology adopts an agile framework to allow immediate release and followup of most important features in small incremental releases. The evolutionary prototypying methodology is illustrated on figure 3.1.

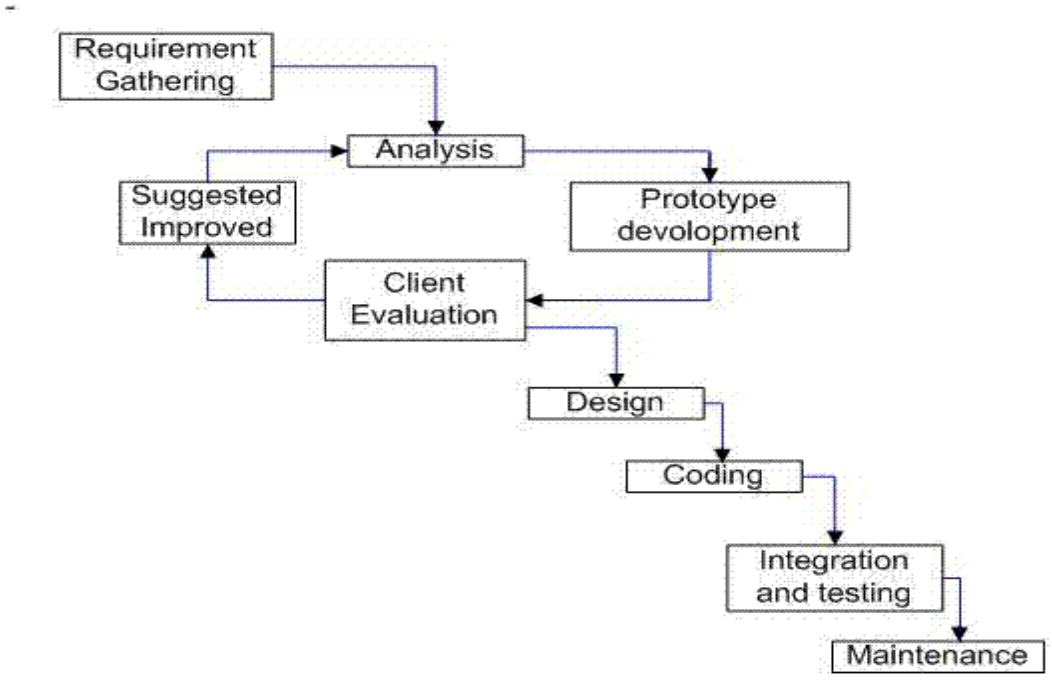

Figure 3.1 Evolutionary Prototyping Phases (Sami, 2012)

3.2.1 Requirement Gathering

Requirements definition was the most crucial part of this research. The research gathered the initial set of requirements from the study of literature review, discussion from potential users and reviewing other software systems, so as to contribute to the understanding of what the system must do.

3.2.2 Requirement Analysis

In the requirement analysis phase, the research analyzed a list of function, non-functional and technical requirements of the system. From the requirements gathered, a prototype was designed. New requirements agreed during analysis were added to the already existing requirements.

3.2.3 Design the Solution

The initial system design began by using the partial design document from the initial requirement document. This was repeated until the software process design of a new prototype occurred to be incorporated on the revised prototype. At this phase, the research used Unified Modeling Language (UML) which is a standard diagramming notation to visualize the designs (Larman, 2005). The functionalities of the application were modelled using the following UML diagrams (Object Management Group, 2015):

i. Use Case Diagram

A use case diagram was used to identify and partition the system functionality, it enabled the research to separate the system into actors and use cases. The actors are the users that directly interact with the system and cause trigger actions from the system. The use case is represented as a text that describes the action the user is effecting on the system.

ii. Design Class Diagram

A design class diagram was used to represent all the classes used in the system and how they are defined. The classes are defined using their attributes and methods. The relationships of the objects and their cardinality values are also shown.

iii. Entity Relationship Diagram

An entity relationship diagram enabled the researcher to create different objects that actually have relationships in real life. Creating the relationships between the entities was very crucial when normalizing the tables within the database in order to eliminate redundancies. An entity has a primary key and attribute.

iv. Sequence Diagram

A sequence diagram models the flow of logic within the proposed mobile application to enhance validation. The diagrams helped to visualize how the users of the mobile application will interact with the various features.

3.2.4 Build the Solution

Once the design was complete, the research created a revised prototype based on the new requirements. The prototype was iteratively modified to respond to design of new requirements. The mobile application was built on Android platform. The source code was written in Java, utilizing Android classes. The application leverages on JavaScript Object Notation (JSON) to read data from the MySQL database on the web service.

The backend web application was built using Code Igniter framework which runs on Hypertext Preprocessor Language version 5 (Code Igniter, 2017). This framework enhances the web backend user interface as well as offer security on the system backend. MySQL database management system is used to store the application data. MySQL is suitable because it is open source and compatible with both Code Igniter framework and Android (Mysql, 2017). Some of the proposed system modules included: user access and management module, portfolio module, sharing module and the news module.

3.2.5 Prototype Integration, Testing and Validation

This phase involved integration of the various modules created and testing the same against different user requirements checks. This included the acceptable responsiveness levels, the acceptable usability levels, the acceptable accuracy levels, the acceptable scalability levels and the acceptable robustness levels as expected from the system. The validation was done through a user acceptance test to ensure that the specified user requirements were met and that the application was working as desired (Tutorials Point, 2017).

3.2.6 System Deployment and Maintenance

After validating the system through various user acceptance tests, the system web backend was deployed online and the mobile application was placed on Google Store with a free access to everyone interested. Maintenance involved keeping on check that all modules of the system were up and running according to benchmarked desired levels.

3.3 Conclusions

This chapter has informed on the research methodology adopted to build the mobile application and the activities done in each phase. It has discussed on the various measures taken to ensure that the final prototype created acts as a solution to the existing problem.

CHAPTER 4: SYSTEM DESIGN AND ARCHITECTURE

4.1 Introduction

This section of the dissertation provides a detailed explanation of the design and architecture of the proposed solution both on Android mobile application and web backend using the Unified Modelling Language (UML). The models used for the design and structure were: wireframes, use case diagrams, use case descriptions, Sequence Diagram, an Entity Relationship Diagram (ERD), a class diagram, and context diagrams.

4.2 Functional Requirements

Functional requirements are the requirements that the application should fulfil to satisfy all the needs required by the scheme users. The requirements include: user management, location aware services, informal builder or contractor portfolio management, news module and a feedback and recommendation module. The user management module enables people to register and login on the application enhancing the ability to recommend a given informal builder or contractor. The location aware services enable a person to use the Global Positioning Services (GPS) on the phone to find a given location and the application lists all the informal builders and contractors near the location. The news module shares the latest news feed on the various ABMTs available in the market. The portfolio module displays the various projects done by either the informal builder or a contractor. The recommendation module enables the user to share some recommendation to the various informal builders or contractors listed on the system.

4.3 Non Functional Requirements

These are requirements that do not affect the way the application works or its core business, the application can still work without it but, are part of the system. They include:

i. Security – The system should allow access to only authorized users.
ii. Usability – The system should have an interface that is easy to use.
iii. Reliability and availability - The system should be reliable and always available to perform user tasks.
iv. Scalability – it should be easy to add additional functionalities into the system.
v. Performance – The system should have an acceptable response time while performing its functions.
vi. Integrity – the system should ensure that data stored is not altered or corrupted.

4.4 System Architecture

This provides a comprehensive overview of the mobile application. The various sub components interact through a centralized database. The prospective home builders access the information about the available contractors or informal builders in a given location though the mobile application. This information is fetched from the database via a web service. The administrator manages the information stored in the database through a web portal. The figure 4.1 shows the mobile application system architecture.

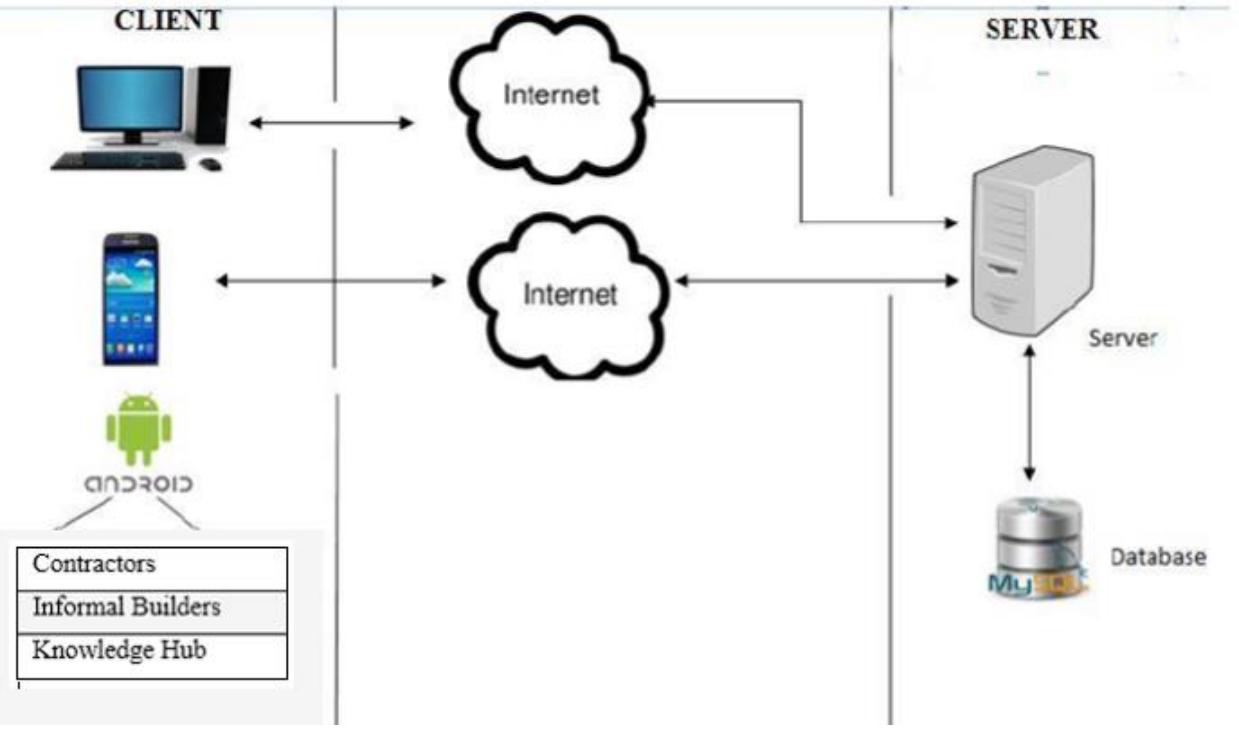

Figure 4.1 System Architecture for the Proposed Solution

4.4.1 Client Side

The client side consists of the Android mobile application. The mobile application allows users to perform various actions including: viewing portfolios of the various service providers get access to knowledge hub menu where they can learn on topics in the building area and also give feedback. Users interact with the application by selecting any of the menus from which the specific data for the menu item will be retrieved.

4.4.2 Server Side

The application server gives information on the queried menu item. It also collects feedback on the various service providers. A system administrator has access to the application server and can manipulate data for secondary reporting.

4.5 System Design

From the requirements identified, the researcher was able to come up with the logical and physical design for the proposed application. The following design acted as a blueprint in helping the researcher develop the proposed system.

4.5.1 Context Diagram

A context diagram was used to represent actors outside of the system that directly interacted with the mobile application. They consisted of entities and relationships. Entities represented the main system while multiple external entities represented external actors. Figure 4.2 shows relationship between entities representing flow of information through a context diagram.

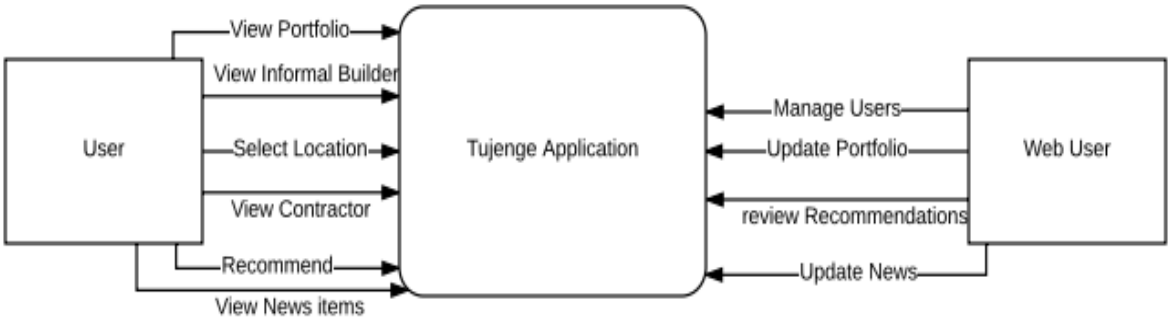

Figure 4.2 Context Diagram

4.5.2 Use Case Diagram

Use case diagrams are used to offer visual representation of the various roles in the system and how they interact with the system. The Figure 4.3 indicates the use case diagram of the system. The actors include the user of the mobile application, the web user and the admin who maintain the web backend of the mobile application.

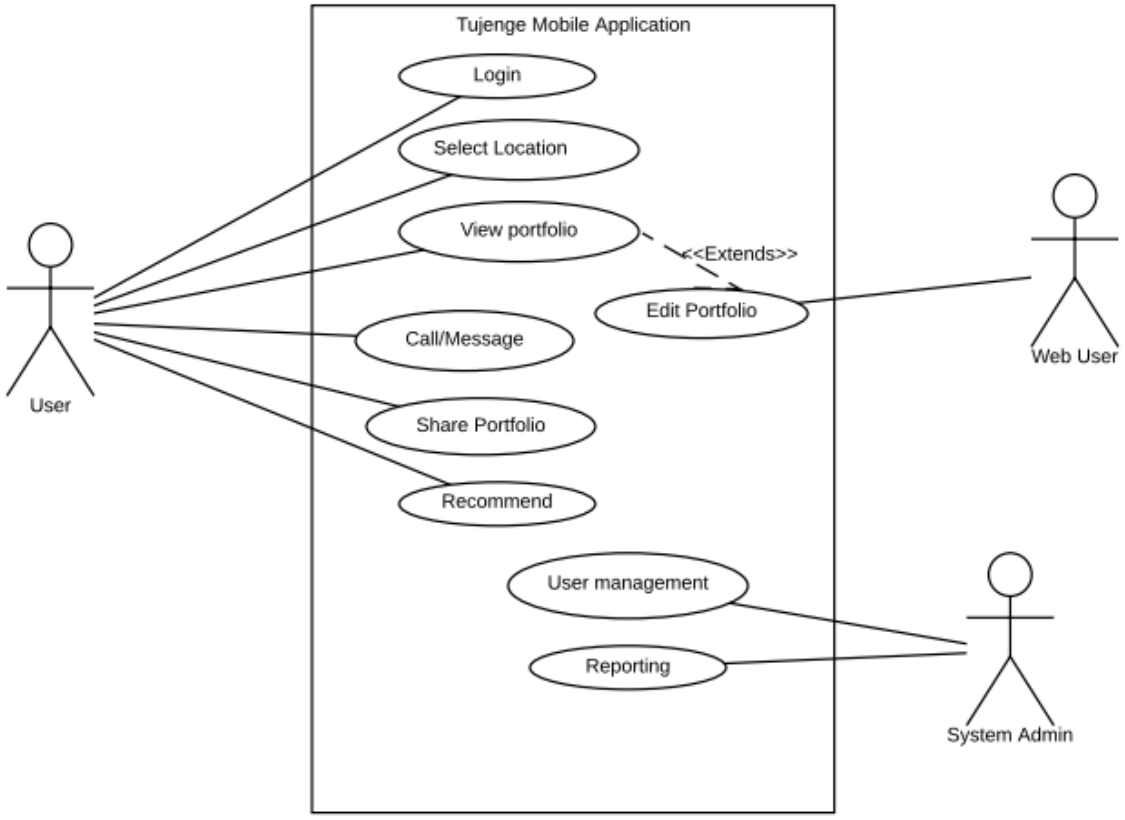

Figure 4.3 Use Case Diagram

To explain the various use cases of the system, Table 4.1 describes the view portfolio use case where the actor is the user of the mobile application. Table 4.2 describes the edit portfolio use case where the actors are the web user and the system admin of the web backend system connected to the mobile application.

Table 4.1 View Portfolio Use Case

Use case Name	**View Portfolio**
Description	This describes how the user logins in to the system and views the portfolio of various contractors and informal Builders listed in the system
Trigger	User Logins in the system and select a given Builder or Contractor
Actors	User
Flow of Events	1. User logins 2. User Selects a particular Builder or Contractor 3. User views the portfolio
Alternate Flows	1a. User cannot login because the user is not registered. 3a. User selects the portfolio and shares it on his/her networks

Table 4.2 Edit Portfolio Use Case

Use case Name	**Edit Portfolio**
Description	This use case describes how items can be added, edited or removed in portfolio
Trigger	Agent logins in the admin backend and selects portfolio
Actors	Web User, System Admin
Flow of Events	1. Login in the system 2. User Selects a particular Builder or Contractor 3. Select Edit Portfolio
Alternate Flows	1a. Web User cannot login because he/she is not registered

4.5.3 Sequence Diagram

The figure 4.4 shows the flow of interactions of the various modules of the system from when the user log in, conduct their business till they log out. Once the user downloads the application, they do not have an account, they register and then redirected to the login page. Upon the log in they are directed to select your current location, then the Google Map page where they can select a Builder or Contractor who is near the current location. Then view their portfolio details.

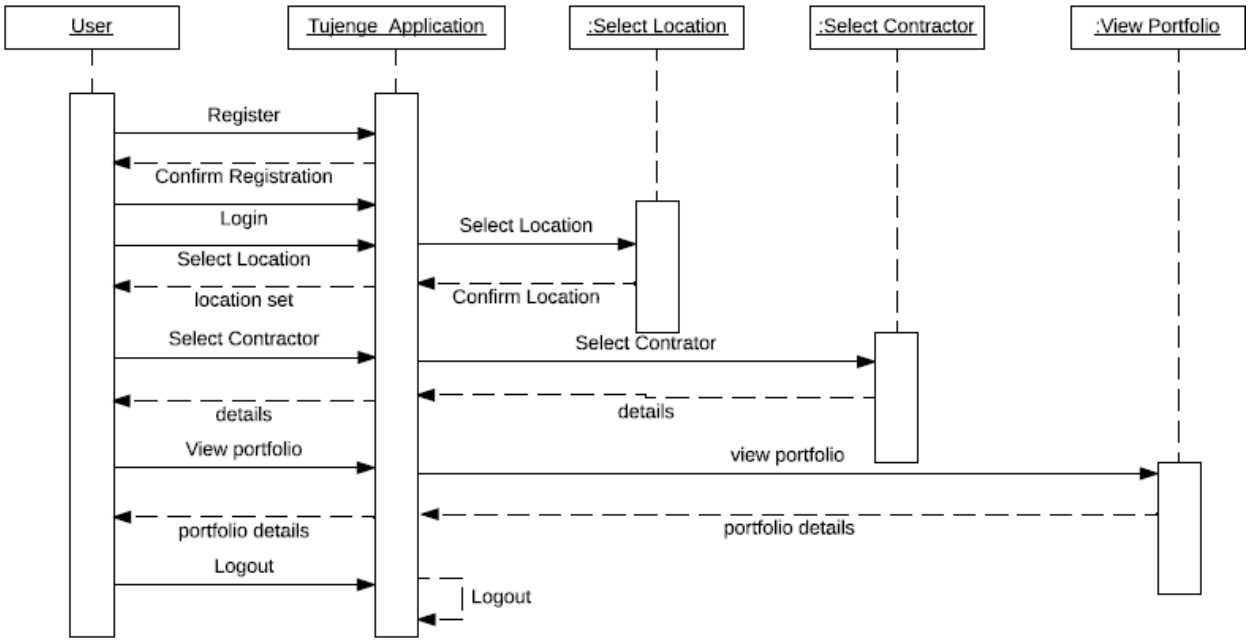

Figure 4.4 Sequence Diagram

4.5.4 Design Class Diagram

The figure 4.5 shows the class diagram of the mobile application which enables us to view the interaction of all the classes in the system and all the attributes they need to have. A class defines the methods and variables it contains.

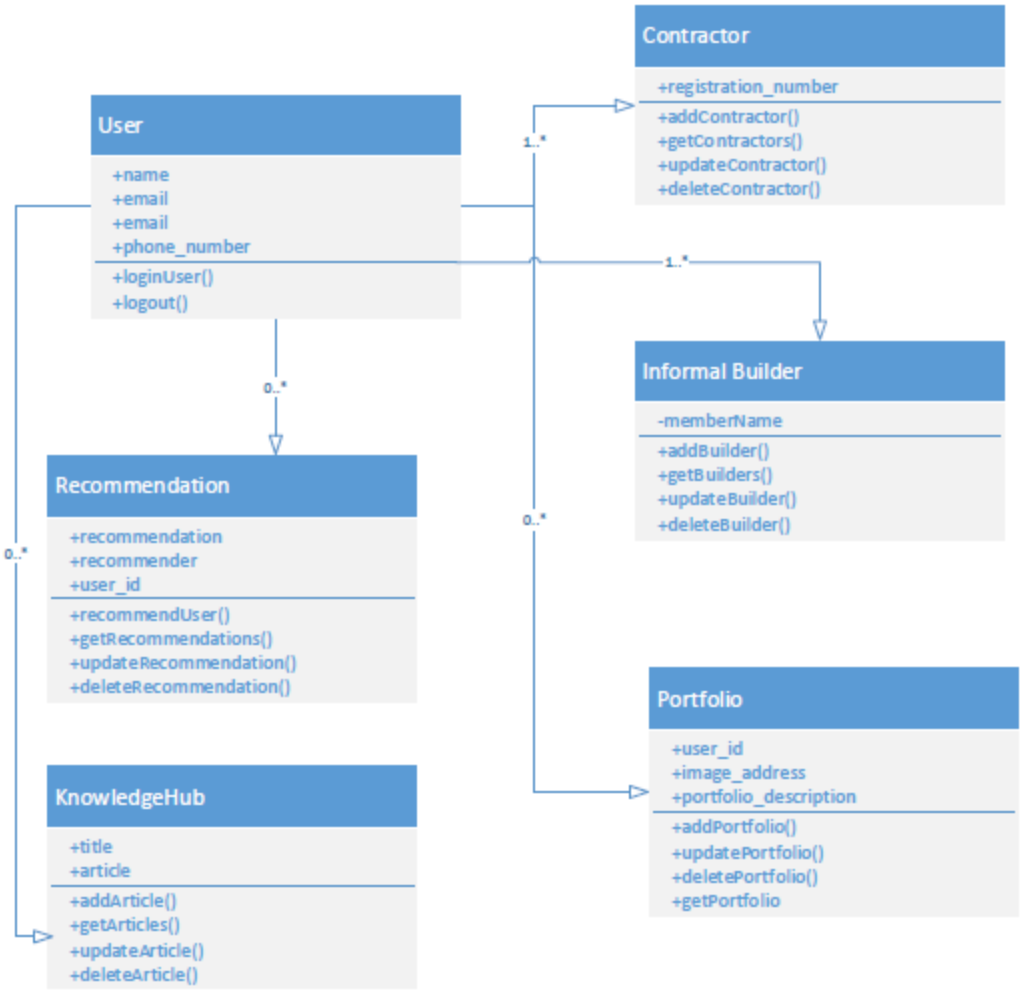

Figure 4.5 Design Class Diagram

4.5.5 Entity Relationship Diagram

The mobile-based application and the web backend communicated with the same database. The Entity Relationship Diagram (ERD) shown by Figure 4.6 was used to represent the database entities and their relationships

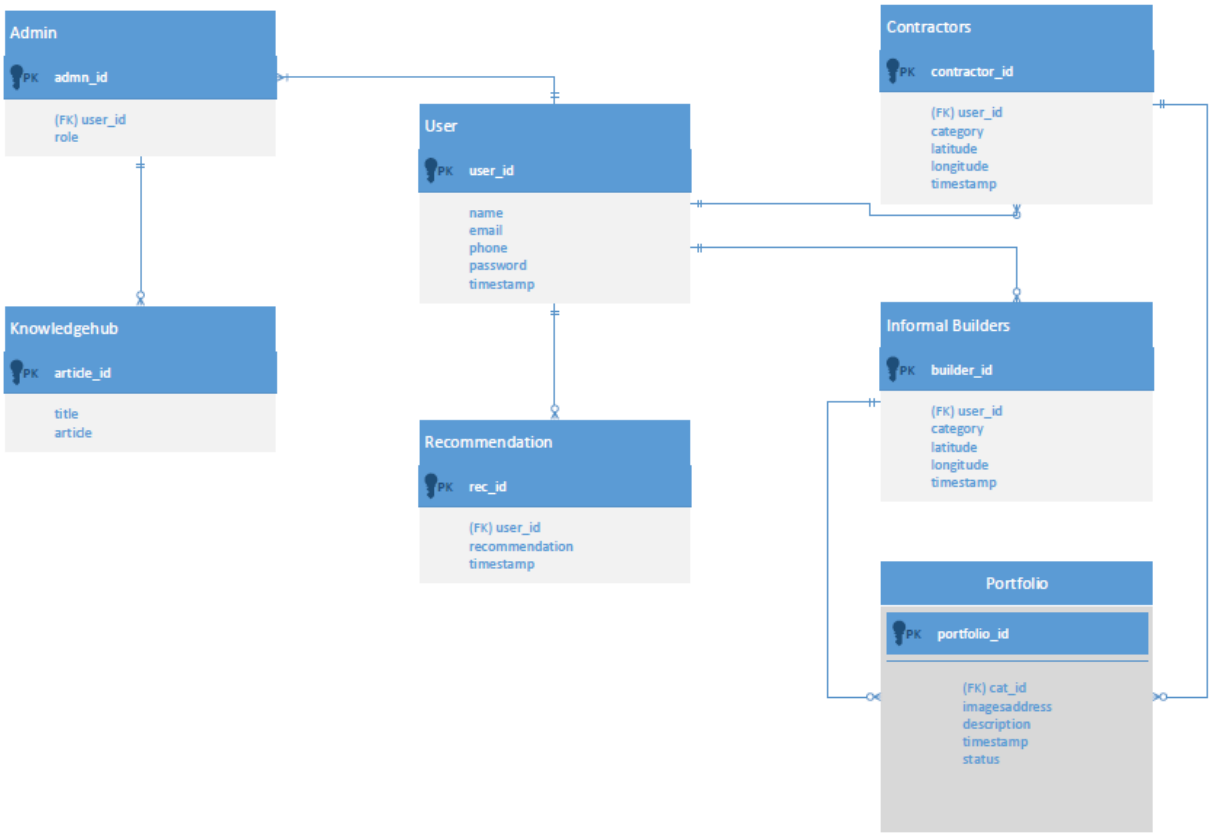

Figure 4.6 Entity Relationship Diagram

4.5.6 Database Schema

The database schema provides detailed description of the database, detailing the entities' attributes, primary keys, foreign keys.

Table 4.3 User Management Table

Column Name	Data Type	Index
User_id	Int(30)	Primary Key
Email	Varchar(30)	
Phone	Varchar(30)	
Password	Varchar(30)	
Timestamp	DATETIME	
Type	Varchar(30)	

Table 4.4 Informal Builders and Contractors Table

Column Name	Data Type	Index
Cat_id	Int(30)	Primary Key
Name	Varchar(30)	
Category	Varchar(30)	
Phone_number	Varchar(30)	
Description	Varchar(90)	
timestamp	DATETIME	
Latitude	Float(10,3)	
Longitude	Float(10,3)	

Table 4.5 Portfolio Table

Column Name	Data Type	Index
Port_id	Int(30)	Primary Key
Cat_id	Int(30)	Foreign Key
Images_address	Varchar(30)	
Description	Varchar(90)	
Timestamp	DATETIME	
Status	Enum (“YES”,”NO”)	

4.5.7 Network Design

Network design was also an important aspect to consider so as to know how the solution would fit in a network infrastructure context. In this case, for one to use the application he/she needs to be connected to the internet. The web backend is the thick client and the mobile application is a thin client whose work is to query the saved data. Figure 4.7 shows the network design.

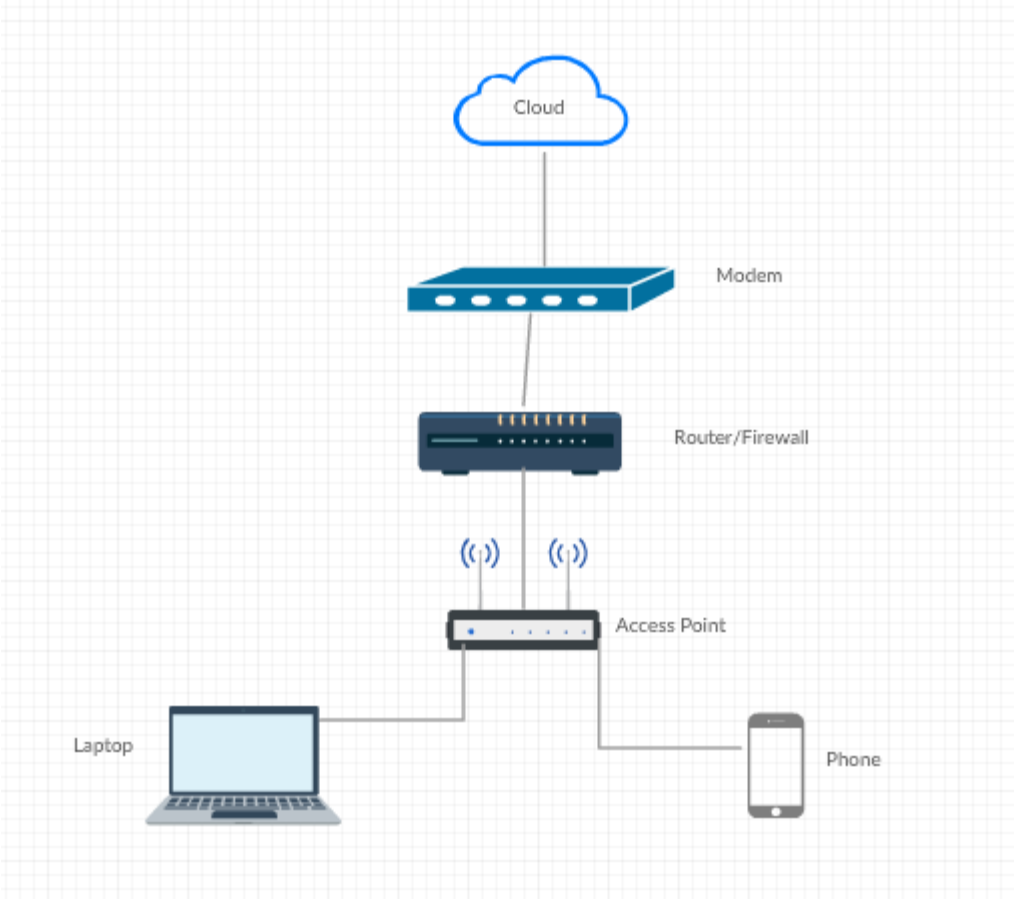

Figure 4.7 Network Design

4.5.8 Security Design

Security was a key concept in design. To access the application, one has to input a password which is stored in the database and it is encrypted using the MD5 encryption algorithm. The web portal is also secured using sessions and other web security features to ensure no MySQL injection can be performed. The authentications upon login on the web portal also buttress the security.

4.5.9 Application Wire Frames

A wireframe is a low-fidelity representation of a system design. The wireframe diagrams can be found at Appendix B. When the application is run first it opens a splash screen which then opens the login page. On successful login, it takes you to the landing page which is the navigation panel for the various options in through the mobile application.

The users of the application need to register using their email address, phone number and a password. Revisiting users need to input their username (email address) and password to gain access. Figure B.1 shows the login and register screens.

Once the user is authenticated, the application requests for the current location. This is automatically detected if the smartphone GPS is on. Then it opens a Google Map landing page showing all the informal builders and contractors near the current location as shown in Figure B.2. From the markers on the map, the user can select a contractor or informal builder and view their portfolio of the projects done before as shown in Figure B.3. The user can also share/refer the selected contractor or informal builder on his/her networks, call, send message to connect.

The users will be able to read latest news on the various appropriate building materials and technology (ABMT) which are populated on a list view as shown on Figure B.4.

The mobile application is supported by a web based backend portal. From the portal, the web users and the system admin will be able to add, remove, and edit categories items. Figure B.5 shows the web backend landing page.

4.9 Conclusions

The system analysis and design helped to understand the requirements of the system. The UML diagramming notation was used to create diagrams to aid in application design. The data flow diagrams showcased the interaction of the system with the external entities and the processes of the system. The use case diagram was used to showcase the various processes on the mobile application. The sequence diagram was used to illustrate the system processes within the system. The entity relationship diagram showcased the database design.

CHAPTER 5: SYSTEM IMPLEMENTATION AND TESTING

5.1 Introduction

This chapter describes the implementation of the proposed application. The functionalities of the various modules implemented are also going to be discussed with use of screen-shots to help the reader visualize the system.

This chapter also provides the system testing procedures which include functional testing where the system functionality was tested against the functional requirements, acceptability testing and usability testing which was conducted by potential users and their feedback analyzed.

5.2 Implementation Environment

To have a clear understanding of the actual implementation of the prototype, this part provides the implementation environment for the web application, mobile application and database. The implementation details in the preceding section provide descriptions of major system components and explanation of implementation procedure.

5.2.1 Mobile Application Prototype

Android platform version 2.1 was used for the mobile application implementation. The application source code was written in Java, making use of Android classes. The application was then compiled and tested using the Android Software Development Kit (SDK) emulator and also a Samsung smart phone running android version 4.0. JSON was used as the web service that gives the interface between the Android application and the database.

5.2.2 Web Application

The web application was built using Codeigniter 3.1.2 web framework. Codeigniter is a powerful PHP framework which is open source, simple and elegant in creating web applications.

5.2.3 Database

To store application data for web application, the MySQL community server 5.7 database was used. This is because MySQL community edition is a freely downloadable version which is also open source with an active community of users and developers.

5.3 Implementation Details

Below we shall discuss in detail how the mobile and web applications were implemented. The mobile application was meant for finding constructors and informal builders while the web application is where their details are fed into the system.

5.3.1 The Mobile Prototype

The mobile prototype can run on any phone with an Android operating system version 4.0 or later versions. Internet connection is required in order to run the application.

System Components

The main system components of the application are:

5.3.1.1 Application Login

To gain access to the application, users have to login using a username and password. In order to get login credentials a user has to create an account which has to be validated and activated by an administrator. For each login, the username and password are validated to ensure security and prevent unauthorized access. Figure 5.1 shows the login screen for the mobile application.

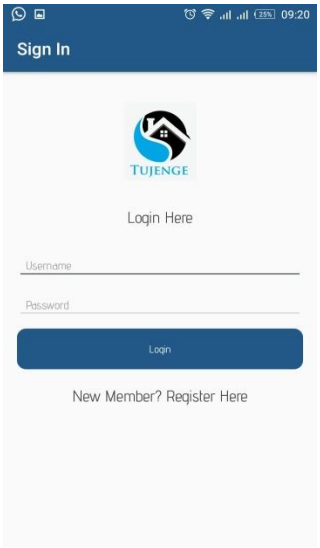

Figure 5.1 Login Screen

5.3.1.2 Register

The screen shown in Figure 5.2 shows the user registration screen from which new users can register to get access into the system.

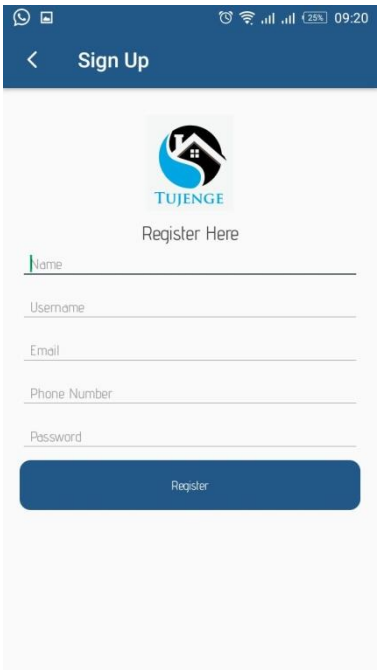

Figure 5.2 Register Screen

5.3.1.3 Home Page

This screen as shown in Figure 5.3 shows the main page which showcases the various menu items: Contractors, Informal Builders, Knowledge hub, About Us, Help and Feedback.

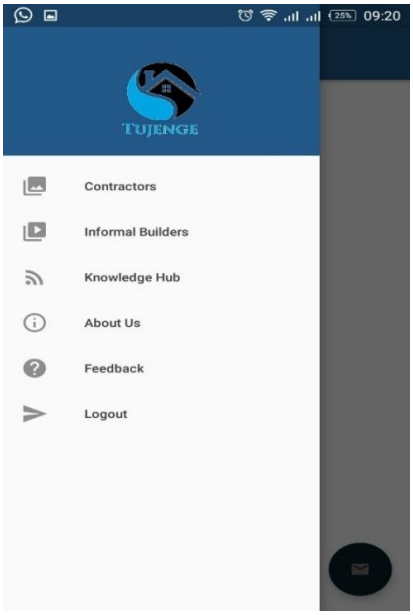

Figure 5.3 Home Page

5.3.1.4 Google Maps

The Figure 5.4 shows the Google Maps page showing the nearest contractor or informal builder near ones location.

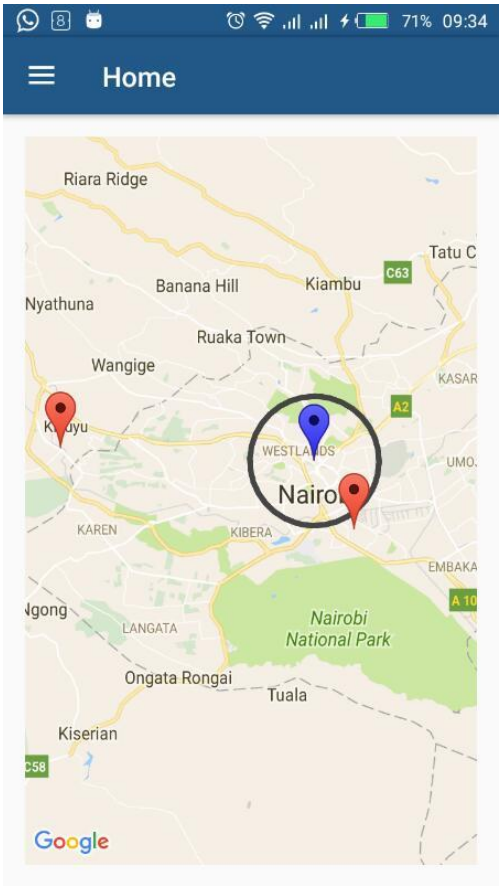

Figure 5.4 Google Maps

5.3.2 Web Application

The main system components of the *tujenge* web application are:

5.3.2.1 Admin Panel

The screenshot in figure 5.5 shows the administrator panel from which the portfolios can be added:

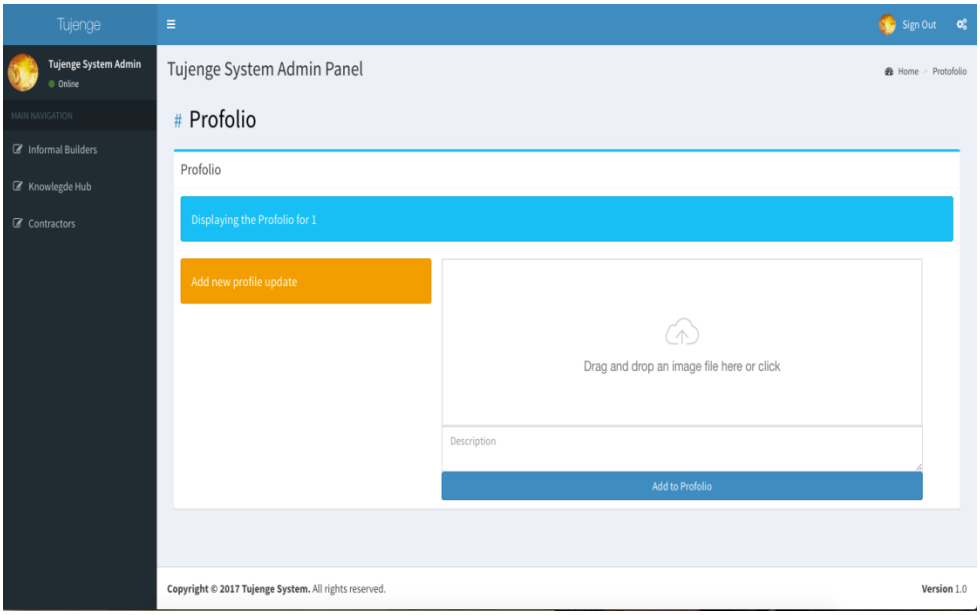

Figure 5.5 Admin Panel

5.3.2.2 Contractors Menu

Figure 5.6 shows the contractors menu from where the administrator can add details of a contractor into the system:

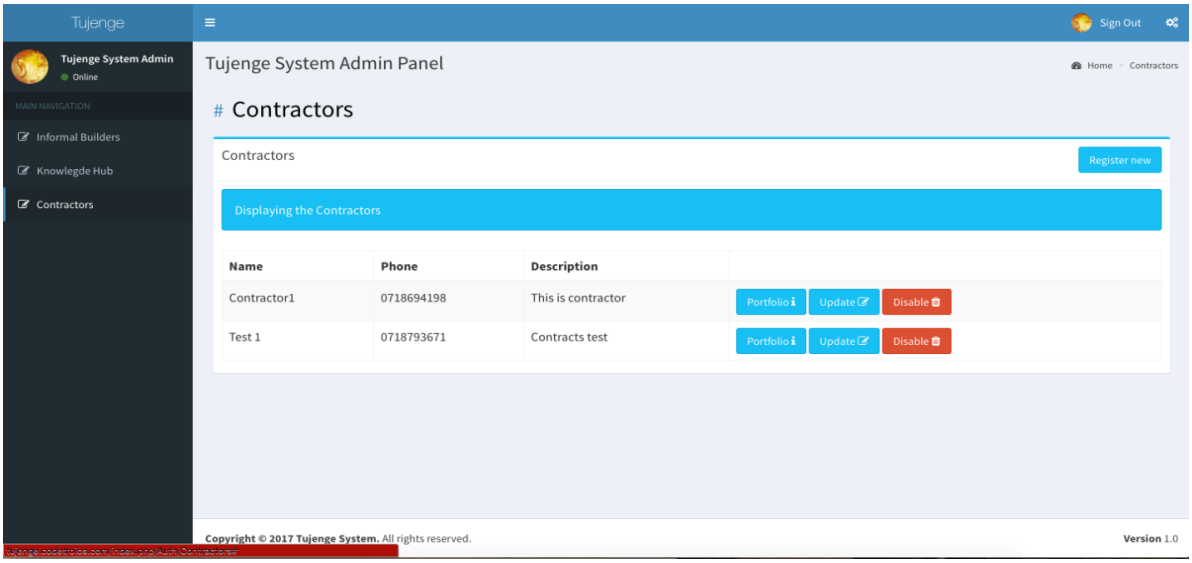

Figure 5.6 Contractors Menu

5.3.2.3 Informal Builders

The screenshot in figure 5.7 shows the informal builders menu from which the administrator can register the informal builders and update their portfolios:

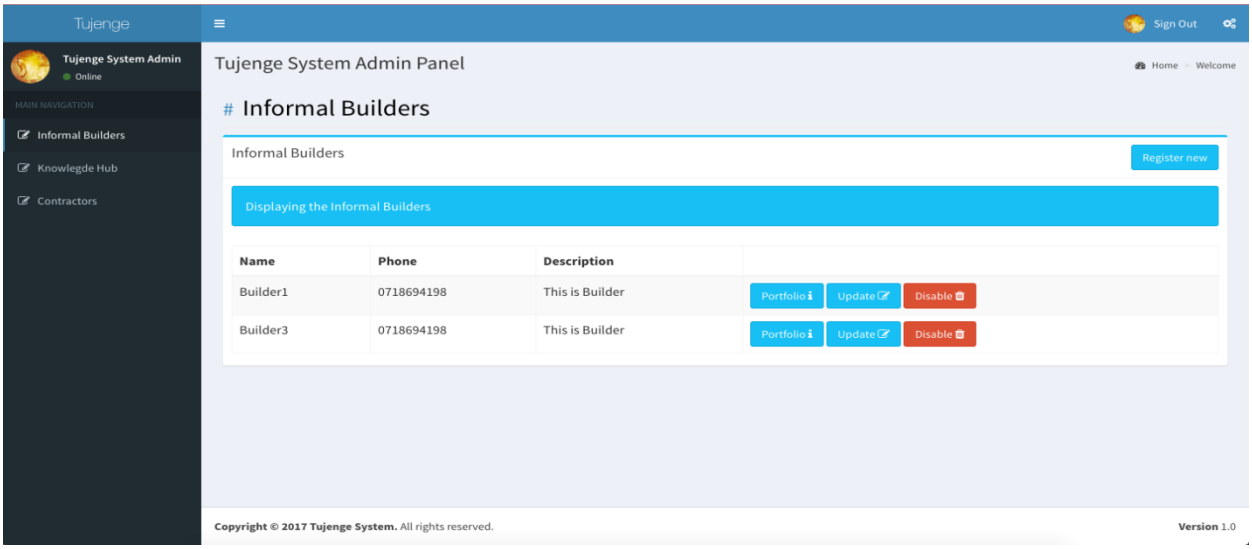

Figure 5.7 Informal Builders Menu

5.3.2.4 Knowledge Hub Menu

The screenshot in figure 5.8 shows the knowledge hub menu from which the administrator can add information about ABMT technologies.

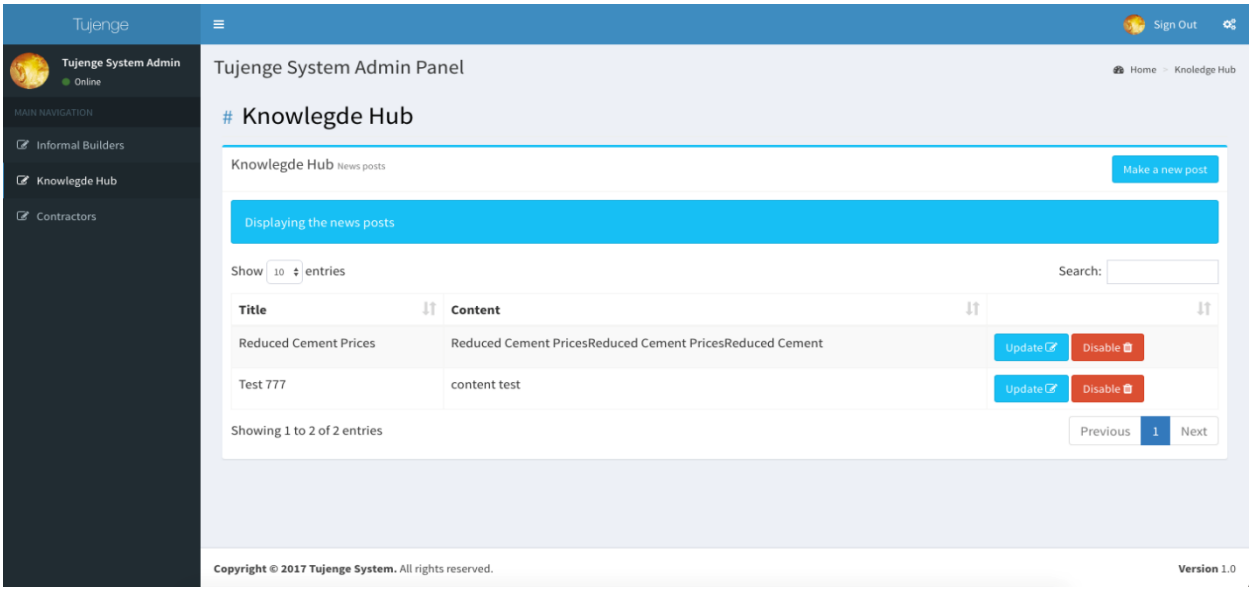

Figure 5.8 Knowledge Hub Menu

5.4 System Testing

This section gives explanations on tests carried on the application to see whether it achieves the set objectives. It shall also give explanations on the types of tests used on the proposed application. A test questionnaire attached in Appendix A below was also sent to the users to know what they thought of the application. The tests include:

5.4.1 Usability Test

This is used to determine whether the application is user friendly. This type of testing was used to ascertain whether a new user can easily understand the application even before interacting with it so much. The major things checked were: the system flow from one window to another, whether the icons and words used were visible and easily understood by user.

5.4.2 Functional Testing

Functional testing is used to test whether the functions of the application are working as per the specification of the system requirement. Testing was applied on the contractor's module to see if the contractor details would be loaded when selected from the application.

5.4.3 Load Testing

Load testing was used to gauge the performance of the application, resource utilization rate, response time, and the application breaking point. This was important to determine how long the application takes to respond, under what circumstances the application fails and how long it takes to give back results.

5.4.4 Integration Testing

In this test, individual units of the application are combined and tested together. This type of testing was used to gauge how the entire application performed when all the units were integrated and made to work together.

5.4.5 User Acceptance Testing

This helps to gauge whether the system meets the specified user requirements. The users are given the application to interact with and then give a report on whether it meets all its requirements.

The following are explanations of some of the test cases done on the application

Table 5.1 Login and Logout

Identifier	1
Test Case	Login or out of the application
Description	Users perform login with a username and password pair then logout.
Utilized Used Case	Login and Logout
Results	Successful login and access granted or Successful logout
Pass/Fail	Pass

Table 5.2 Register Account

Identifier	2
Test Case	Register account
Description	User registers an account by feeding in the required details.
Utilized Used Case	Register Account
Results	Account registered successfully.
Pass/Fail	Pass

Table 5.3 View Portfolio

Identifier	3
Test Case	View
Description	User chooses a menu e.g. contactors and views portfolio.
Utilized Used Case	View Portfolio
Results	Process successful.
Pass/Fail	Pass

5.5 User Testing

User testing is a very important aspect in the development. This is because the users are the people who will benefit directly from the application. Their feedback on the application is important so as to gauge whether the goals set have been met or not. The areas tested included,

user friendliness of the application, functionality, acceptability and quality of interface design. For this to be achieved, a total of 25 respondents were asked to test the application and give their response on the same.

5.5.1 User Friendliness

This refers to the response the system gives to the users in an event the user has started a particular function. It also refers to the ability of the user to know when a process is in progress. Figure 5.9 represents the views of the respondents on a chart.

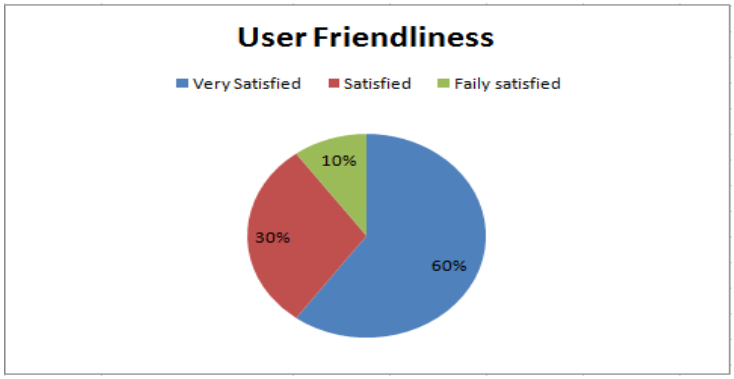

Figure 5.9 User Friendliness

5.5.2 Functionality

The respondents were asked to indicate their views on the functionalities of the application. Figure 5.10 represent the responses on a chart.

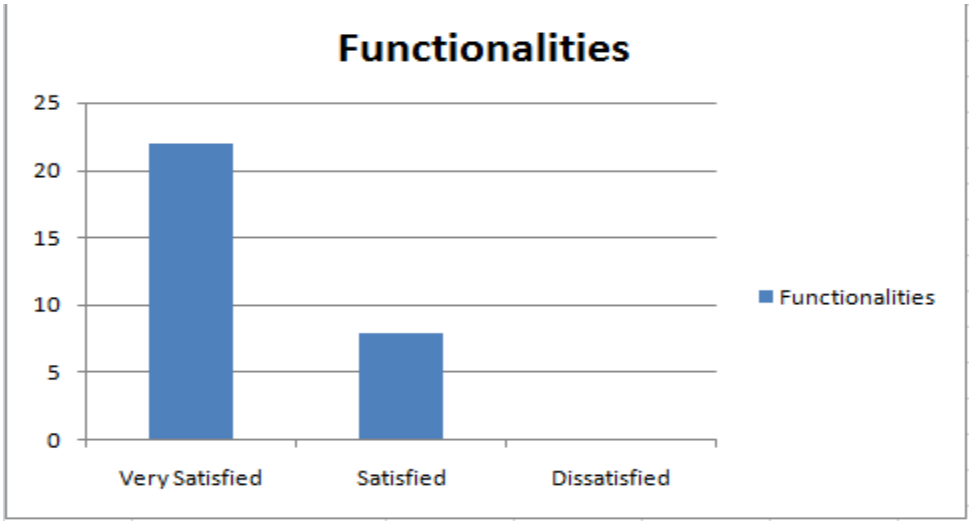

Figure 5.10 Functionality

5.5.3 Acceptability

The respondents were asked if they would accept to use the application if it was to be launched. Figure 5.11 shows the responses on a chart.

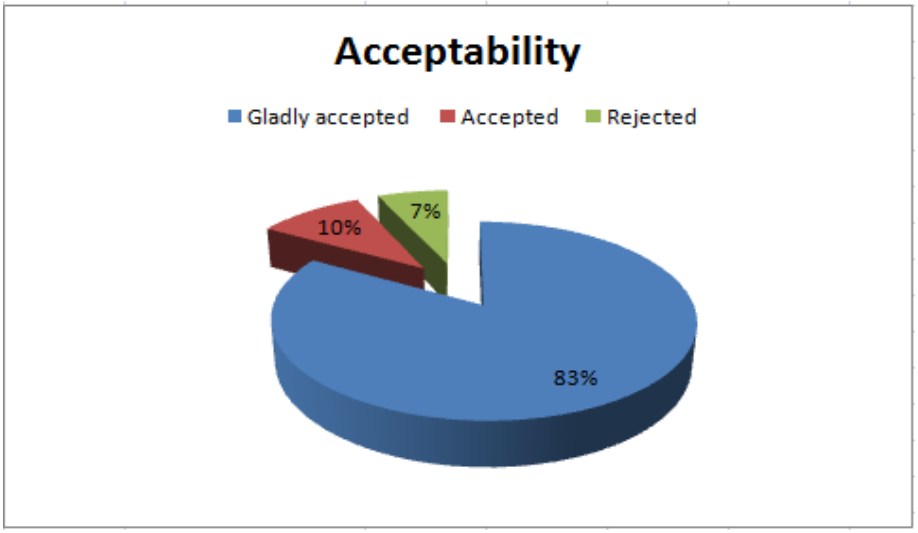

Figure 5.11 Acceptability

5.5.4 Interface Design

The respondents were also asked to give their view on the interface of the application. Figure 5.12 below represents the result on the figure below.

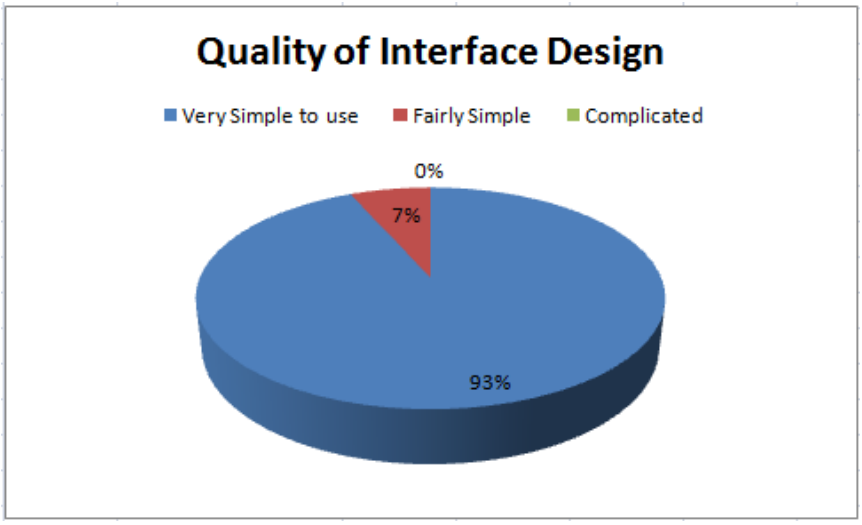

Figure 5.12 Interface Design

5.5.5 Validation

This was done in order to ascertain whether the implementation addressed the raised issue which was lack of information on the available credible contractors who are near the location of the client. The figure 5.13 shows what the potential users thought of the implementation and how it addresses the issues.

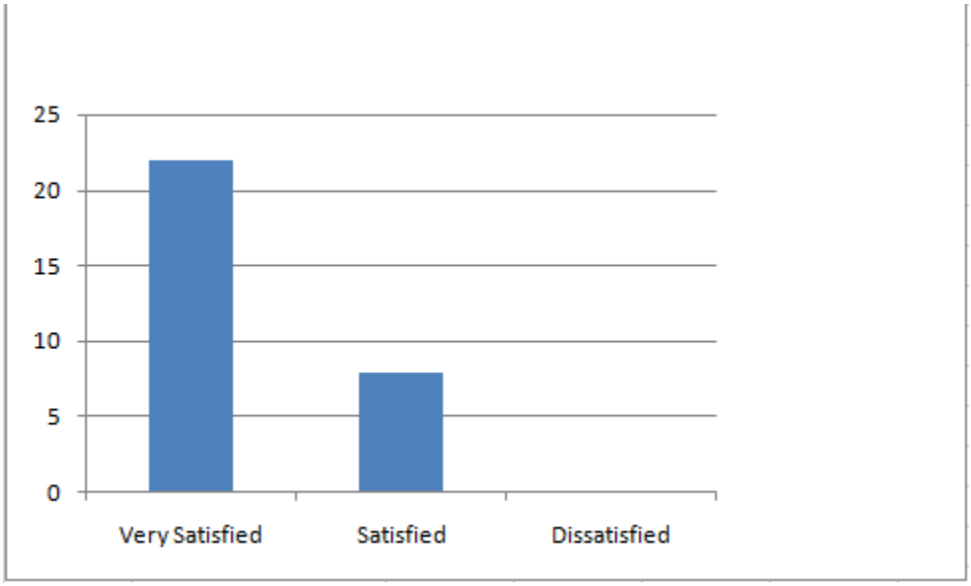

Figure 5.13 Validation

From the above figure we can see that majority of the users were very satisfied that the implementation addresses the raised issues.

5.6 Conclusions

In the user requirement and problem analysis stage, all the system requirements were pointed out. This helped to successfully develop an application that would meet all the set objectives and also meet the user requirements.

Therefore, most of the set objectives were met with the implementation of the application. This was made possible by the methodology used, which is evolutionary prototyping, because it facilitated constant inflow of information from possible users and other experts, that helped in coming up with the best design for the application.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

This chapter discusses the results of the work done in the previous chapters highlighting the findings and achievements. Also, after the application was tested and all functionalities seen to be working, the study sought to see if the objectives were covered. It also shows how the objectives that were set have been accomplished.

6.2 Explanation of Findings

In chapter 1, the background of the study brought out the details about housing and property industry and the challenges faced. Problem statement, research objectives and research questions were also introduced in this chapter.

Chapter 2 supported the research objectives by discussing in depth the building and construction techniques, reviewed existing solutions that have been developed, and lastly discussed the proposed solution and what gap it filled that the existing solutions had not yet filled.

Methodology used in this research was discussed in chapter 3 that would facilitate user requirement collection and also development of the proposed solution. Requirement gathering was done by observation, one on one interviews and surveys System Design was done in chapter 4 which showed design of the application from the use case, class diagrams, entity relation diagrams and database schema. System architecture was also discussed in this chapter.

Chapter 5 showed the system implementation which was supported with screen shots fully explained. Various test cases were carried out on the application and their outcomes explained to show if the application achieved it objectives. Validation was also discussed here with an info graphic showing what the users thought of the implementation in regards to addressing the raised issues.

6.3 Discussions

This section explains how the study was able to meet the research objectives that were set up at the beginning.

The first objective was to identify the common sources of information used while constructing a house, the study shows a lot of challenges that users face in trying to find credible contractors who are near their location and in Chapter 2 the research captures in detail the various challenges.

The second objective was to review the current solutions for providing house construction information; this was meant to find the gaps in this field. As can be seen from chapter 2, various challenges were pointed out one of them being that there is no application to aid in finding service providers in the building and construction area near ones location. It is due to this challenges that a need for the application developed was justified.

The final objective was to design, develop and test an automated system to provide information on house construction and aid in finding the service providers near ones location. This objective focused on design and development of the application, it sought to establish a way to create a design and develop the system. In chapter 4 the study showed the various ways through which the system can be designed. In chapter 5 the study shows how the application was designed with regards to the requirements. The application was then developed and the test questionnaires given to the sample population that tested the application. Their views are given in chapter 5 under user testing.

Also, the application was tested to find out if the various functionalities worked as required. The developer did a lot of testing while doing development for the application and the results are discussed in chapter 5, then the users were also given the application to test and their results are highlighted in Section 5.5. It was concluded that the application's functionalities worked as required and the results indicated supported this.

6.4 Advantages of the Proposed System Compared to the Current Systems

The application was compared with the current systems and these were the results:

i. It's easy to use and does not require any training
ii. The application offers a choice by offering various details of builders and constructors
iii. It can be accessed anywhere because it is online
iv. Keeps the user updated in terms of the latest ABMT in the market

v. The application creates a point of contact between a prospective client and the service providers
vi. It helps in saving the cost as it shows a client the resources around one's area

6.5 Disadvantages of the Mobile Application

i. The mobile application only runs on Android, hence locking out users with other mobile operating systems.
ii. The setup requires and active internet connection. The system cannot work without an active connection to the internet.

6.6 Conclusions

In conclusion, the application received good feedback from the sample population with most of them being positive in using it once launched. The results from the validation which was done in order to ascertain whether the implementation addressed the raised issues which were lack of location aware services in locating service providers in the building industry was also positive as can be seen from figure 5.13.

CHAPTER 7: CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK

7.1 Conclusions

Information about housing and property industry, techniques used and challenges facing house construction in Kenya was reviewed. From the analysis carried out, the results pointed out that there are a few issues that the potential users wanted to be addressed.

The result was the development of *tujenge* system which includes a mobile and web application. The key features of the application include: view and contact genuine service providers near ones location and access to building and construction information. The application was aimed at coming up with a solution that would bridge the gap in finding information on the available credible contractors who are near the location of the client. System testing was performed to gauge if the look and feel, ease of use, system functionality and acceptance met user requirements.

7.2 Recommendations

To benefit from the system, it is recommended that one downloads the application on phones running on Android platform and use it. The mobile application is of great importance to the users who want to construct houses as the best and genuine contractors in the industry are fed into the system and one can view their portfolio, their location and track their ratings and reviews to make wise decisions.

7.3 Future Work

The solution provided in this research is of help but there is room for improvement. This is attainable because, technology is continuously improving and more technological tools are being built on a daily basis that could further even more discoveries. Therefore, the following are areas that could be explored in future to improve this solution.

i. The mobile application should be developed for other mobile platforms to allow users who do not have Android to access the mobile application's functionality.
ii. The system should be developed to cater for other players in the housing and property industry and not just contractors and informal builders.

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APPENDICES

Appendix A: Mobile Testing Questionnaire –Tujenge Application

User Testing Questionnaire

1. Did you manage to perform the following task? (Indicate Yes or No)

a) Login and out of the application

b) View Menus

c) View Portfolios

d) Create Account

e) Submit feedback

2. How did you find the user interface of the mobile and web application based on their look and feel?

- ☐ Very Simple
- ☐ Fairly Simple
- ☐ Complicated

3. Rate the system functionality based on whether it met the user requirements (functionality)

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Dissatisfied

4. Would you accept to use the system to find service providers in building a house?

- ☐ Gladly accept
- ☐ Accept
- ☐ Reject

5. Are you satisfied that the implementation addresses the issues of finding the service providers near ones location?

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Dissatisfied

Appendix B: Application Wireframes

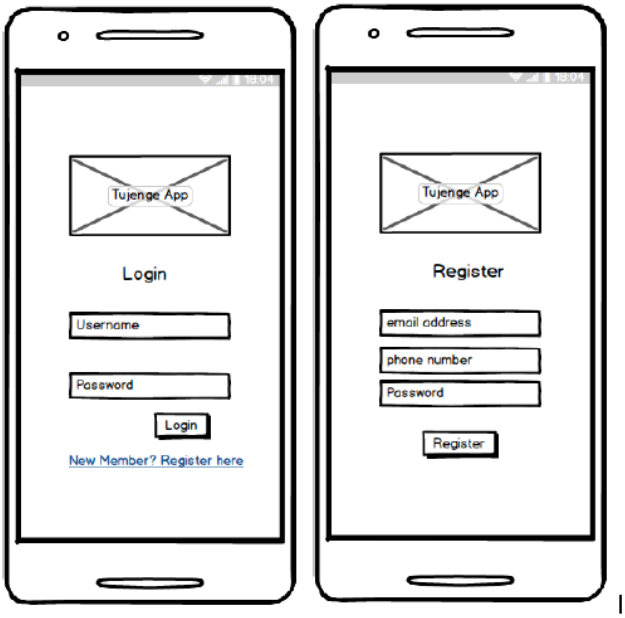

Figure B.1 Login and Register Screens

Figure B.2 Menu Landing Page

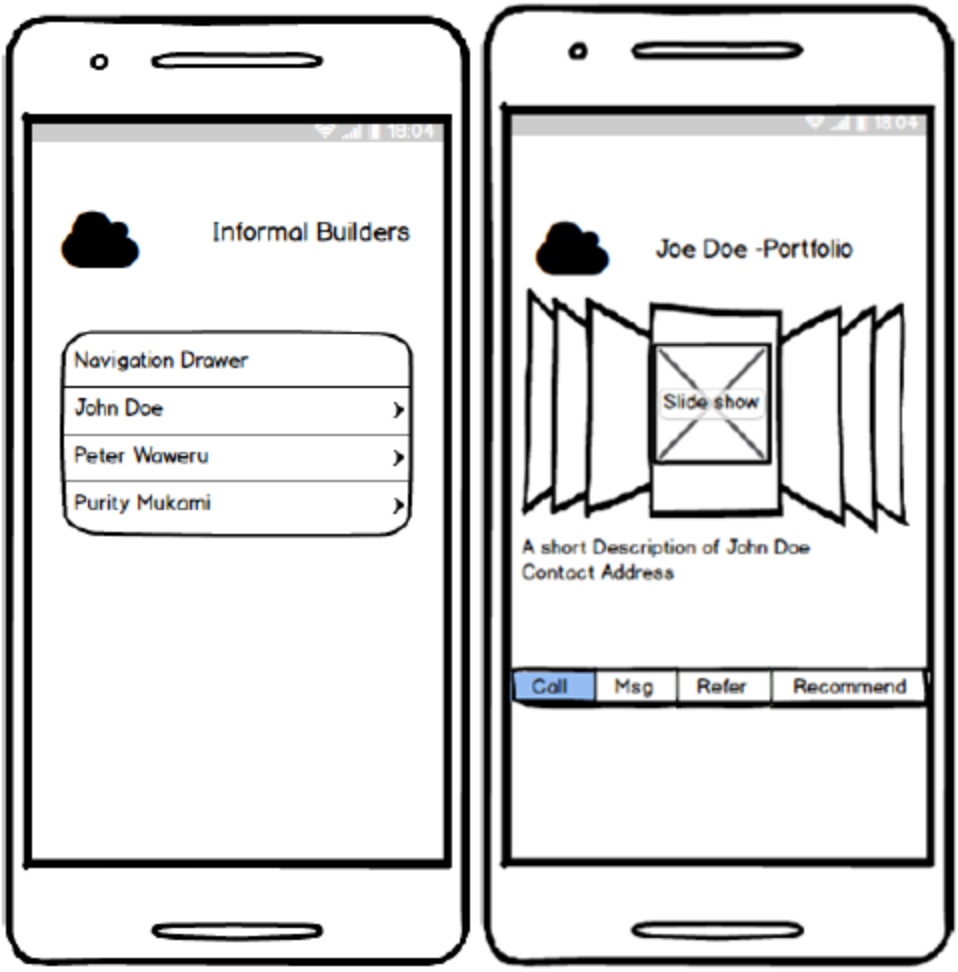

Figure B.3 Viewing Portfolio Items

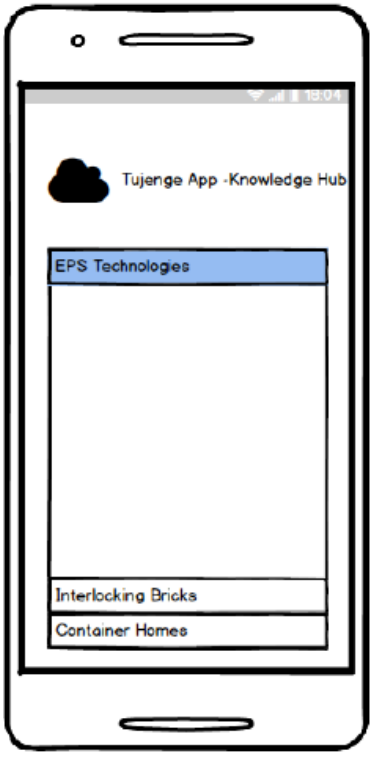

Figure B.4 Latest News Portal

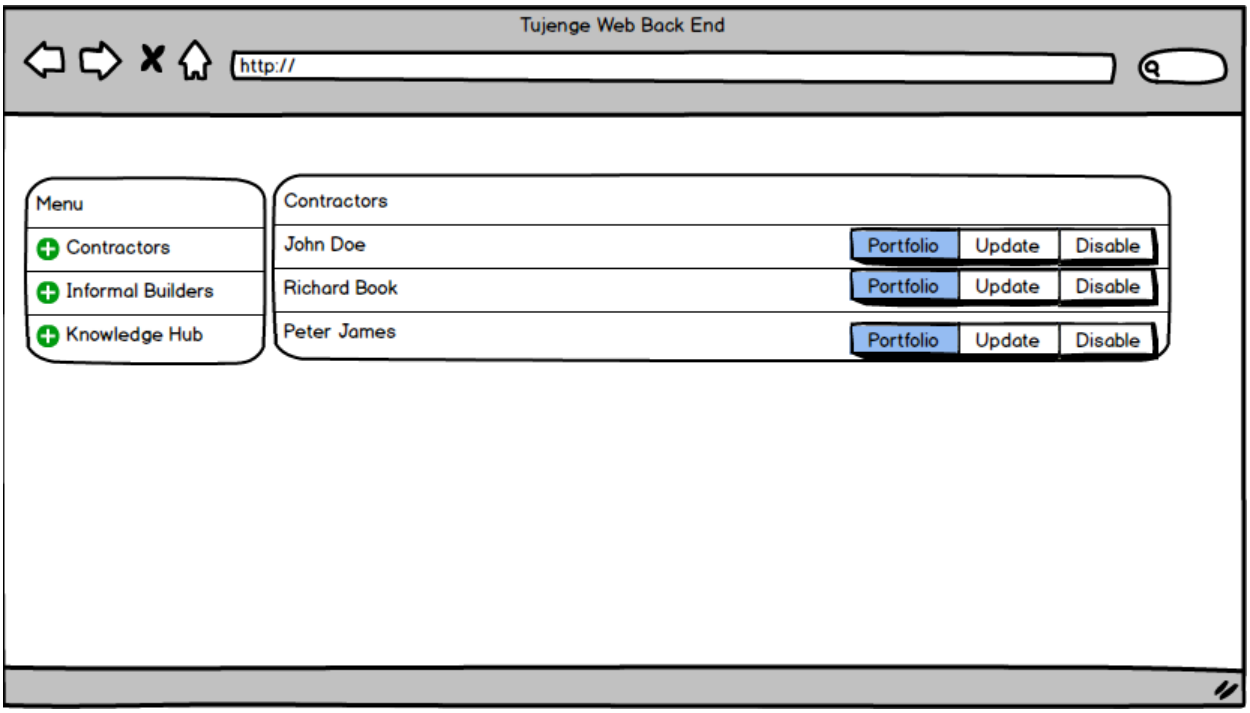

Figure B.5 The Web Backend Portal

Appendix C: Turnitin Report

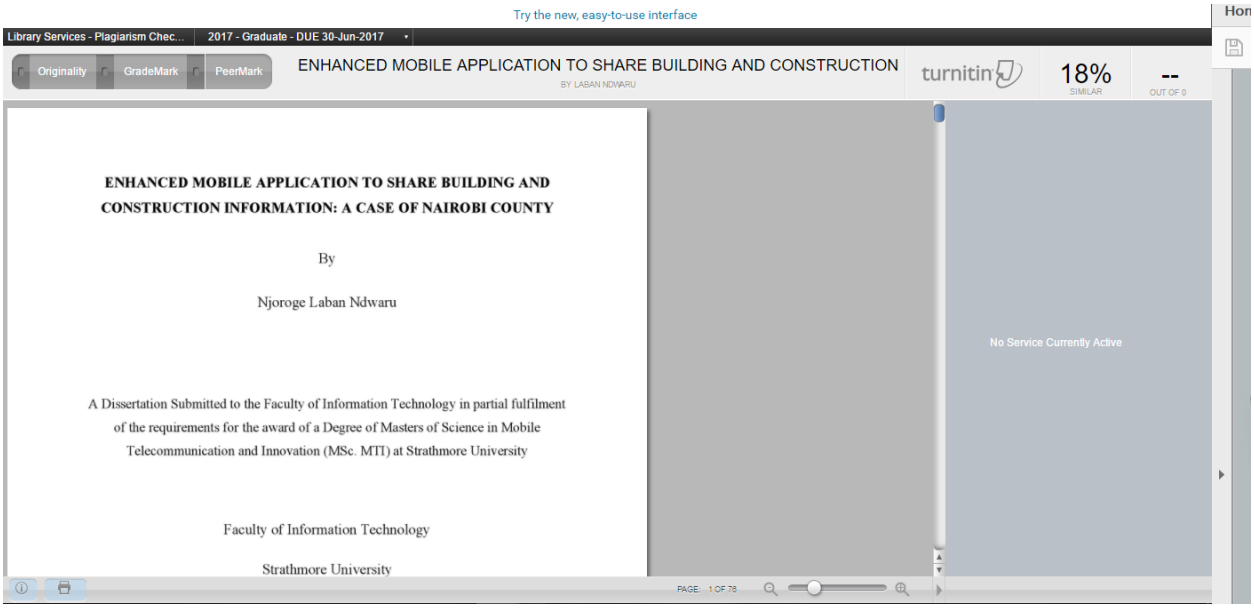

Figure C.1 Turnitin Originality Report