

[Electronic Theses and Dissertations](#)

2019

A Tool for tracking land transactional activities: case of land registry in Kenya

Regina W. Muriuki
Faculty of Information Technology (FIT)
Strathmore University

Follow this and additional works at <https://su-plus.strathmore.edu/handle/11071/6727>

Recommended Citation

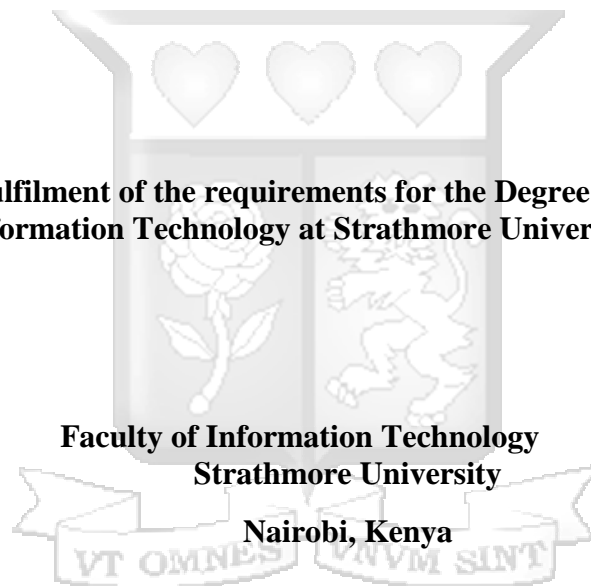
Muriuki, R. W. (2019). *A Tool for tracking land transactional activities: Case of land registry in Kenya* (Thesis, Strathmore University). Retrieved from <http://su-plus.strathmore.edu/handle/11071/6727>

This Thesis - Open Access is brought to you for free and open access by DSpace @Strathmore University. It has been accepted for inclusion in Electronic Theses and Dissertations by an authorized administrator of DSpace @Strathmore University. For more information, please contact librarian@strathmore.edu

A Tool for Tracking Land Transactional Activities: Case of Land Registry in Kenya

Muriuki, Reginah Wairimu

**Submitted in partial fulfilment of the requirements for the Degree of Master of Science in
Information Technology at Strathmore University**



**Faculty of Information Technology
Strathmore University**

Nairobi, Kenya

June, 2019

This thesis is available for Library use on the understanding that it is copyright material and that no quotation from the research thesis may be published without proper acknowledgement.

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.

© No part of this dissertation may be reproduced without the permission of the author and Strathmore University

Muriuki, Reginah Wairimu

.....

12th June 2019

Approval

The dissertation of Muriuki Reginah Wairimu was reviewed and approved by the following:

Dr. Vincent Omwenga (PhD)

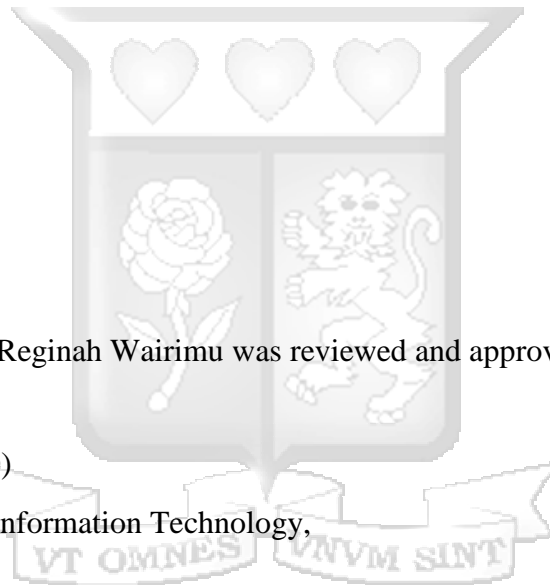
Senior Lecturer, Faculty of Information Technology,
Strathmore University

Dr. Joseph Orero

Dean, Faculty of Information Technology
Strathmore University

Dr. Ruth Kiraka

Dean, School of Graduate Study
Strathmore University



Abstract

Land transactions contribute significantly to the economic activity, growth and development of a country. With a steady increase in population and devolution of land registries in Kenya, land transactions take place all over the country and on a daily basis. Efficient and effective land transactions are therefore crucial. The current land structure is highly paper based and marred with many land Agents. The storage of these land transactions is mostly paper based which is susceptible to change or physical damage. On the other hand, the digitized records are accessible to a few and lacks transparency and security. To access the digitized records takes days which questions how well the system works and how efficient it is even with smaller tasks as search. This Thesis looks to analyze the land transactional activities in the land registry in Kenya and also to review the land transactional activities tracking tools that are used in the land registry system. The scope of this thesis is based on the development of a technological and information based tool that would facilitate the tracking, recording, storage and retrieval of land transaction activities over time. The tool employs the use of Blockchain technology to guarantee immutability, transparency and data integrity. The solution implementation of the research is based on transparency and ease of transactions, hence, protection of the buyer, seller and owner of the land from fraud.



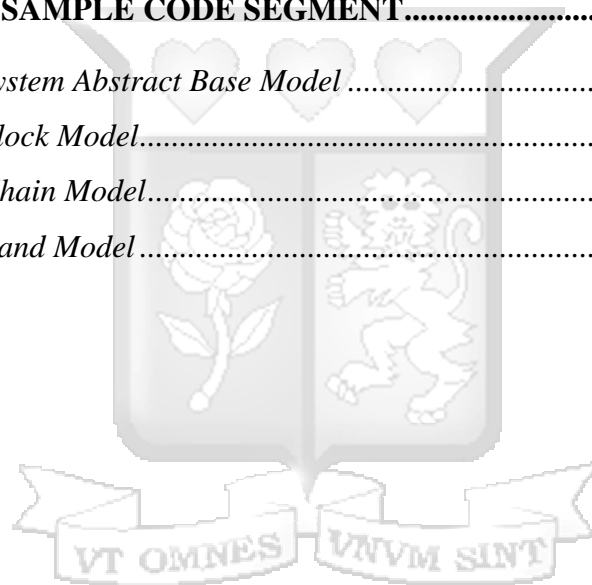
Table of Contents

ABSTRACT.....	III
LIST OF FIGURES	VIII
LIST OF TABLES	IX
LIST OF ABBREVIATIONS AND ACRONYMS	X
ACKNOWLEDGEMENTS	XI
DEDICATION.....	XII
CHAPTER 1: INTRODUCTION TO THE STUDY.....	1
1.1 BACKGROUND OF THE STUDY	1
1.2 PROBLEM STATEMENT	2
1.3 GENERAL OBJECTIVE.....	3
1.3.1 <i>Specific Objectives</i>	3
1.4 RESEARCH QUESTIONS	3
1.5 SIGNIFICANCE OF THE STUDY	3
1.6 SCOPE OF THE STUDY.....	4
CHAPTER 2: LITERATURE REVIEW	5
2.1 INTRODUCTION	5
2.2 LAND TRANSACTION.....	5
2.2.1 <i>Origin of Land Transaction in Kenya</i>	5
2.2.2 <i>Development of Land Transaction Regimes in Kenya</i>	7
2.3 REGISTRATION OF DOCUMENTS (DEED SYSTEM).....	7
2.3.1 <i>Registration of Documents Act 1902 (Cap 285) (RDA)</i>	8
2.3.2 <i>The Land Titles Act, 1908 (Cap 282) (LTA)</i>	8
2.3.3 <i>Government Lands Act, 1915 (Cap 280)</i>	9
2.4 REGISTRATION OF TITLES SYSTEM	9
2.4.1 <i>The Registration of Titles Act 1920, (Cap 281) (RTA)</i>	10
2.4.2 <i>The Registered Land Act 1963 (300)</i>	10
2.5 THE PROCESS OF LAND TRANSACTIONAL ACTIVITIES.....	10

2.5.1	<i>Land Adjudication</i>	10
2.5.2	<i>Land Consolidation</i>	11
2.5.3	<i>Demarcation</i>	11
2.5.4	<i>Land Group Representative</i>	11
2.6	CADASTRAL SYSTEMS	12
2.7	EXISTING GAP.....	13
2.8	BLOCK CHAIN CONCEPTS	14
2.8.1	<i>Existing Solutions on Block Chain Transparent and Secure Land Activities</i>	14
2.8.2	<i>Application of Block Chain in Land Transactional Activities</i>	15
2.9	CONCEPTUAL FRAMEWORK	16
CHAPTER 3: RESEARCH METHODOLOGY		19
3.1	INTRODUCTION	19
3.2	RESEARCH DESIGN	19
3.2.1	<i>Mixed Research Design</i>	19
3.3	POPULATION AND SAMPLING	20
3.4	DATA COLLECTION METHODS	21
3.4.1	<i>Questionnaires</i>	21
3.5	DATA ANALYSIS	21
3.6	RESEARCH QUALITY (VALIDITY AND RELIABILITY)	22
3.7	SYSTEM DEVELOPMENT METHODOLOGY.....	22
3.8	ETHICAL CONSIDERATION	24
CHAPTER 4: DATA ANALYSIS, SYSTEM DESIGN AND ARCHITECTURE...		25
4.1	DATA ANALYSIS	25
4.1.1	<i>Results from Questionnaire</i>	25
4.2	REQUIREMENT ANALYSIS	30
4.2.1	<i>Functional Requirements</i>	30
4.2.2	<i>Non-Functional Requirements</i>	31
4.3	SYSTEM ARCHITECTURE	31
4.3.1	<i>Identity layer</i>	31
4.3.2	<i>Certifying Layer</i>	31

4.3.3	<i>Hyper Ledger</i>	32
4.4	SYSTEM DESIGN.....	34
4.4.1	<i>Level 0 Context Level Diagram</i>	34
4.4.2	<i>Level 1 Data Flow Diagram</i>	35
4.4.3	<i>Use Case Models</i>	37
4.4.4	<i>Use Case Narratives</i>	39
4.4.5	<i>System Sequence Diagram</i>	40
4.5	SYSTEM WIREFRAMES	41
CHAPTER 5: IMPLEMENTATION AND TESTING		45
5.1	INTRODUCTION	45
5.2	DEVELOPMENT TOOLS.....	45
5.3	SYSTEM REQUIREMENTS.....	45
5.4	SYSTEM FUNCTIONALITY	45
5.4.1	<i>Sign Up</i>	46
5.4.2	<i>Login</i>	46
5.4.3	<i>Search Page</i>	47
5.4.4	<i>Land Details</i>	48
5.4.5	<i>User Profile</i>	49
5.4.6	<i>Block Chain Generation</i>	50
5.5	SYSTEM AND INFORMATION SECURITY	51
5.6	SYSTEM TESTING	52
5.6.1	<i>Unit testing</i>	52
5.6.2	<i>Integration Tests</i>	53
5.6.3	<i>User Acceptance Tests</i>	54
CHAPTER 6: DISCUSSIONS		56
6.1	INTRODUCTION	56
6.2	RESEARCH AND TOOL REVIEW	56
6.3	LIMITATIONS AND ASSUMPTIONS OF THE DEVELOPED TOOL	57
6.4	BENEFITS OF THE DEVELOPED TOOL.....	58
CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS.....		60

7.1 CONCLUSIONS.....	60
7.2 RECOMMENDATIONS FOR FURTHER RESEARCH	60
REFERENCES.....	62
APPENDICES.....	65
APPENDIX I: RESEARCH QUESTIONNAIRE.....	65
<i>Section A: General Information.....</i>	<i>65</i>
<i>Section B: Impact of Current System.....</i>	<i>65</i>
APPENDIX II: USE CASE NARRATIVE.....	67
APPENDIX III: SAMPLE CODE SEGMENT.....	69
<i>Section A: System Abstract Base Model</i>	<i>69</i>
<i>Section B: Block Model.....</i>	<i>74</i>
<i>Section C: Chain Model.....</i>	<i>76</i>
<i>Section D: Land Model.....</i>	<i>78</i>



List of Figures

Figure 2.1: Current Land Process	12
Figure 2.2: Conceptual Framework Diagram	18
Figure 3.1: Applied Research Design	20
Figure 3.2: RAD Development methodology	23
Figure 4.1: General Response Rate.....	26
Figure 4.2: Stakeholders Response Rate.....	26
Figure 4.3: Efficiency of Current System	27
Figure 4.4: Security of Data.....	28
Figure 4.5: Challenges with Current System	29
Figure 4.6: Rating the Current System	29
Figure 4.7: Necessity for New System	30
Figure 4.8: System Design.....	33
Figure 4.9: Level 0 Context level Diagram	35
Figure 4.10: Level 1 Data Flow Diagram	36
Figure 4.11: Land Administrator Use Case	37
Figure 4.12: Owner/Seller Use Case.....	38
Figure 4.13: Buyer Use Case	39
Figure 4.14: System Sequence diagram.....	41
Figure 4.15: User Log in Screen wireframe.....	42
Figure 4.16: Search view wireframe	42
Figure 4.17: Search details view wireframe	43
Figure 4.18: Land detail view wireframe.....	44
Figure 5.1: Signup form view	46
Figure 5.2: Login screen view	47
Figure 5.3: Land search view.....	48
Figure 5.4: Land detail view	49
Figure 5.5: User Identity/Profile view	50
Figure 5.6: Land transactions chain view	51

List of Tables

Table 4.1: Response rate to the questionnaires	25
Table 4.2: User Identity Scenario Narrative	40
Table 4.3: Buyer Land transaction Scenario	68
Table 4.4: Seller Land Transaction Scenario	69
Table 5.1: User Access Level Matrix	52
Table 5.2: Sample Unit tests	53
Table 5.3: Sample Integration Test	54
Table 5.4: User Acceptance Test	55



List of Abbreviations and Acronyms

GLA – Government Lands Act

IMA – Identity Management Authority

LCB – Land Control Boards

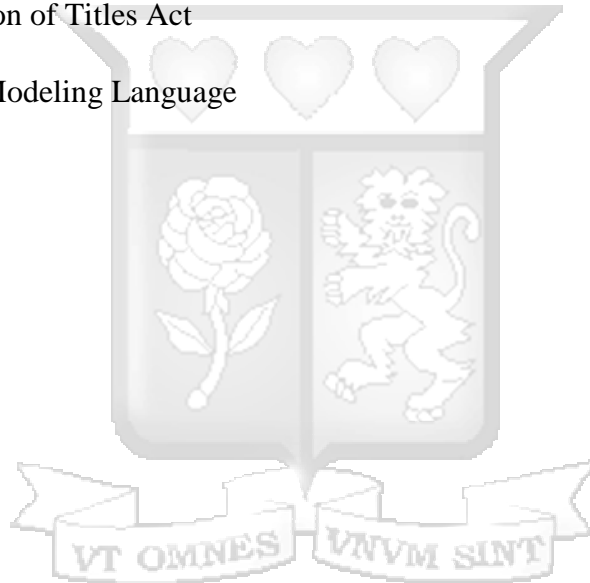
LTS – Land Transactions System

RAD – Rapid Application Development

RDA – Registration of Documents Act

RTA – Registration of Titles Act

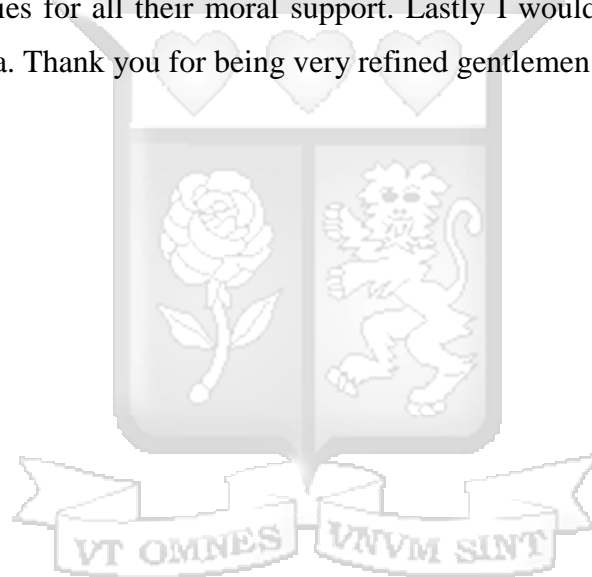
UML – Unified Modeling Language



Acknowledgements

First and foremost i want thank God, for his ever present help. Lord you have been a Father indeed!

My heartfelt gratitude also goes to my supervisor, Dr. Vincent Omwenga, for his continued support, guidance and patience throughout my research. I also want to thank my parents for there ever present support and in a special way thank my Mum, posthumously who went to heaven five months ago for especially interceding for me to accomplish this. A special thank to My brother Solomon Ndoria and my sister Juliet Gathigia and their families who have always been such a darling to me, not forgetting my family abroad Leah Randiak, Joseph Wachiuri and Esther F. Nduta and their families for all their moral support. Lastly I would not forget my new fond friends Oscar and Mamba. Thank you for being very refined gentlemen!



Dedication

I dedicate this work to my Dad and Mum Mrs & Mrs James Muriuki Githae, who inspired me in words, action, and spirit to brave and conquer it all and especially my Mum Mrs Joyce Nyokabi Muriuki who never lived to see me graduate even after so much effort but who is in a better place now, Heaven!

Special dedication to all My Nieces and Nephew Shana Salome, Vianney James, Chantel Nyokabi, Alexia kirigo, Ranley Olaro, Phenius Jimmy, Shalyn Nyokabi, Adrin Wanjohi, Joel Wachira, Trea Clara Nyokabi, baby Jayden Ndoria and many unborn children, Dear little ones, the future belong to you, go for it!



Chapter 1: Introduction to the Study

1.1 Background of the study

Land transactions contribute significantly to the economic activity, growth and development of a country. Since the colonial era, Kenya has operated a purely manual land registration system. The current land law recognizes paper based transactions only. For Electronic registration system to be actualized reference is being made to the land laws of Kenya, consultation with land law experts is being done so as to formulate a suitable legal framework. President Uhuru Kenyatta's quest to automate land transactions will remain work in progress after a taskforce looking into the issue had its term extended according to standard Newspaper, (2018). The Taskforce has faced numerous challenges in its effort to fully activation of a digital land transaction process and especially the numerous efforts by interested parties like lawyers derail the process.

The current and existing land transactions have had several drawbacks, including first, the lack of a central repository for land records. All data collected were stored in different formats. This was not only confusing, but also hindered data access. Second, the different processes meant tedious amounts of paperwork and lengthy queues. This impacted the turnaround time on transactions for land owners and buyers and has led to the use of brokers by land owners to hasten the process (Soar & Muigai, 2018). The standards of some of the land records also allowed for easy manipulation and some fraudulent transactions. Many lost confidence in the veracity of the title deeds issued to them and were generally discouraged by the high costs of land transactions. Third, the vast amount of data collected resulted in bulky records, requiring significant amounts of storage space (Soar & Muigai, 2018). Land registry employees complained of the heavy records that had to be retrieved and the poor conditions of documents as many of them were very old.

World Bank identified land transfer challenges as a major impediment to investors injecting funds into various projects in Kenya. Kenya improved 19 places to stand at position 61 thanks to efforts made to protect minority investors and digitization of the tax declaration system that reduced time spent on filing tax returns. According to World Bank's research on ease of doing business report(2018), the land transfer process to registration of property, which on

average takes 49 days, gave Kenya the lowest rating at 55.97 per cent to stand at position 122 out of 190.

Land transaction activities are faced with modern requirements to digitize its information for ease of access and retrieval (Kalantari, et al., 2015). With technology advancing at an increased speed through the application of computers, the internet and other technologies, the process of land transaction activities need to also be digitized for efficient service delivery and secure storage of immutable information (Kalantari, et al., 2015). The requirement for the development of a Land Transaction System (LTS) had begun to be addressed in order to have a broader impact in the management of land and environmental transaction activities. However, there is yet to be a more in depth research on the potential impacts that LTS tool could have (Kalantari, et al., 2015). Accordingly, even though there is general information on individual system reforms on land transaction activities, the need for a detailed analysis of land transaction activities is still imminent.

The main idea of this research is to provide an analysis of the potential tool that can be applied to track and keep immutable records of land transaction activities (Kalantari, et al., 2015). A solution to this problem may be realized by the implementation of a technology set to transform the land registries is known as blockchain, the same technology used to facilitate Bitcoin transactions. Blockchain works in the following way: when a digital transaction is carried out, it is classified together in a cryptographically protected block with other transactions that have occurred in the last few minutes and sent out to the entire network for confirmation. Each category of these transactions is known as a block. The confirmed block of transactions is then time-stamped and added to a chain in a linear, chronological order. The entire chain is consistently updated so that every ledger in the network is the same giving each member the ability to prove who owns what at any given time (Coindesk, 2017).

1.2 Problem Statement

Currently, land transactional activities are centralized at the land ministries headquarters-Nairobi and land devolved offices at the county Headquarters in which the records are not up to date and retrieval is very difficult (Lane, 2014).

The current land system is used by a few individuals with no clear documentation on its operation, confidentiality and integrity measures. The structure put in place by the Land is highly

dependent on agents and third party transfer with high discrimination on types of transfer. Most of the agents in the land ministry and the administrators have many ongoing cases on fraudulent land transfers and unclear transfer process for most the land in the country.

A transparent and reliable information system would allow for increased trustworthy and good decision making. Hence, the need for a tool for tracking land (Van & Lemmen, 2015). The tool would facilitate the user to efficiently survey, plan, register and in turn approve and be allocated the land including lease renewals and subdivision of already owned land.

1.3 General Objective

To analyze and develop a tool for tracking land transactional activities.

1.3.1 Specific Objectives

- i. To analyze the land transactional activities in the land registry Kenya.
- ii. To review the land transactional activities tracking approaches that are used in the land registry.
- iii. To design a tool for tracking land transactional activities in the land registry in Kenya.
- iv. To test the developed tool for tracking land transactional activities in Kenya.

1.4 Research Questions

- i. What are the land transactional activities in the land registry in Kenya?
- ii. What are the existing land transactional activities tracking tools and applications used in the Land registry?
- iii. How will the design of a tracking tool for land transactional activities in the land registry in Kenya be developed?
- iv. How will the proposed tool be tested to track the Land transactional activities?

1.5 Significance of the Study

According to the problem statement, many buyers are falling victims of fraudulent activities and being conned into buying property that is in dispute or that which has already been sold to other people (Lemmen, et al., 2015; Holden, & Otsuka 2014). The essence of the study, therefore, is to create a tool that records immutable record on any form of land transactions (Lemmen, et al., 2015). The tool will be designed to limit unauthorized intrusion, tamper proof, encrypted and open to public. Additionally, the tool will be able to allow for validation and verification of land details before transfer and how the system will be able to initiate the transfer

process from the original owner (Lemmen, et al., 2015; Holden, & Otsuka 2014). For the purpose of transparency, immutability and openness, the system will be significant by working with block-chain technologies. The technology will be integrated to the existing system so that the initial transfer of information from the current system to the new system remains unchanged and approved as required by law.

1.6 Scope of the Study

The study was conducted at Nairobi's lands registry in the Ministry of Lands. This is because the lands registries in the various counties in Kenya have a similar structure, and therefore any system developed in Nairobi would be central and can be replicated countrywide.



Chapter 2: Literature Review

2.1 Introduction

This chapter reviews relevant literature with a view to investigate the research problem and to further understand the concept and the challenges encountered in tracking of land transactions from registration, transfer, selling and buying with the aim to enhance viable and purposeful tracking of transactional activities that are immutable. Next, the theoretical framework that encompasses relevant publications and works by other scholars in the field of Block chain models, cryptography and the development of other systems/tools that have been done. Lastly, the conceptual framework which seeks to amalgamate these ideas with the proposed area of investigation has been done to conclude the chapter.

2.2 Land Transaction

The process of land transaction is a step by step guidelines of officially keeping records of legal rights to a piece of land through titles on properties or deeds. In other terms, land transaction means that one acquires legal records known as the land register that would make them assume ownership and rights on a piece of land or of a deed with respect to the changes in the legal measures of the defined unit of land(Dekker, 2017). In retrospect, land transactions are the documentary representation of a unit of land as a property in the commerce industry. The land register provides the basic function of disseminating relevant information when regarding the transferability and rights in and in the exchange and production process(Dekker, 2017). Not only is a track of land transaction an data bank, but also an expression of the nature and type of tenure operative provided in any society.

2.2.1 Origin of Land Transaction in Kenya

The transactions and subdivision of land in Kenya begun from the ethnic group of Kikuyu. During the colonization by the European, they settled in the parts that were highly fertile in the Mt. Kenya region which was at the time being occupied by Kikuyu's (Manji, 2015). After the completion of the construction of the Ugandan railway in 1902, the colonial government encouraged settlement in order to develop an agricultural economy (Manji, 2015). The crown land ordinance and the East African Land order council of 1904 were responsible for the

alienation of the land to the colonial settlers. Many settler grabbed hold of the native Kikuyus who were expected to offer cheap or free labor.

After independence, the colonial settlers had to leave and the Kikuyu's that had been captured took over the lands as squatters since they did not have official documents to ascertain their ownership (Fazan, 2014). The government after stabilization began the process of taking back its land and had to remove the squatters from the farms, an action that led to agitation and consequently, violence (Fazan, 2014). The alienation of land, restrictions to participate in politics, taxation, expulsion of squatters and restriction to cultivate cash crops resulted to the formation of the Mau Mau rebellion and the resultant growth of the African nationalism that became a widespread phenomenon in the country (Manji, 2015). The Mau Mau rebellion was mostly comprised of the squatters and other landless kikuyu from the rift valley region who through the expropriation of land by local chiefs and colonial government denied them frontiers for expansion.

The uneasiness that resulted from the movement led to the government establishing the Kenya Land Commission of 1962 whose main purpose was to conduct investigation and provide reports on the African claims of the existence of alienated land (Manji, 2015). The commission provided their finding and the lands were compensated but the Kikuyu claimed of being given the alienated land was rejected since the land was used for sisal and coffee plantation. The commission also carried out intermediaries between the Kikuyu people and the white settlers to carry out exchanges so that some kikuyu land would be taken back from the settlers (Manji, 2015). Over time, there was overcrowding in the reserves and the locals began demanding for their individuals' titles to the land so as to have a legal representation in the event of a dispute (Manji, 2015). The colonial government disagreed on the demands of a lands policy after the 1952 state of emergency. However, after some time, there was a move by the Swynnerton plan of 1954 to alter the existing system of land tenure (Manji, 2015). The plan would be achieved through consolidation of individuals into registering freeholds to affect improvements in the reserves.

The plan was based on developing economic growth and minimizing on the chances of a political uprising. Yet again, the plan led to new disputes with contention on the rights and ownership claims on the individual property in land was on the basis of institutionalization many

of those who lost their land as well as former tenants migrated to the rift valley region (Fazan, 2014). The European colonial government, with the aim to minimize on the possibility of seizure on European lands and other revolutions, they came up with a massive settlement scheme which provided additional land to the Africans. By 1961, the Kikuyu reserves had been legally registered making Kenya to be the first African government to decisively opt for the colonial mode of land tenure.

2.2.2 Development of Land Transaction Regimes in Kenya

Back in the 20th century, land for cultivation and settlement was in plentiful proportions with regards to the population size (Dekker, 2017). As such, there was a minimal need for the presence of a land administration and management entity to oversee the distribution and subdivision of land (Dekker, 2017). However, there has been an exponential growth in the population size and sedentary agriculture led to the competition of the remaining available space. It was at this point that land transaction activities became relevant for the documentation of people against the land that they are associated with (Dekker, 2017). The agricultural potential of the Kenyan lands prompted the colonizing power to alienate if for the purpose of economic exploitation. The exploitation and alienation of land were achieved through the application and enactment of the English Laws on the colony (Dekker, 2017). Currently, the Kenyan government has two main systems of land registration which are the registration of title system and the registration of document or deed system.

2.3 Registration of Documents (Deed System)

This system looks to register the need and leave out the title. The deed in this case, is a formal written document that has the signatory and is delivered by the grantor that transfers the title to actual property into another person (the grantee) (Doshi, et al., 2014). Before the deed is signed and safely affected, the current owner of the land has relinquished his proprietorship up to the contentment of the intending buyer to a best root of title. The process is conducted and achieved by performing a rigorous and sequential search through pre-recorded events concerning the land. In the deed system, the registration involves taking a record of each isolated transaction and other evidence such as signatures and fingerprints to indicate that the transaction took place. To affect the deal, necessary entries are made on the document as evidence (Doshi, et al., 2014; Eck, 2014). The disadvantage of this mode is that the registrar does not check the document for

correctness but it is taken as it is by the face value as such, there is no state indemnity to guarantee the title. The deed registration model embodies the following three systems in chronological order.

2.3.1 Registration of Documents Act 1902 (Cap 285) (RDA)

Act 1902 (Cap 285) marked the first ever statute in the republic of Kenya in 1901 with the aim of recording land transactions and to help the public be more aware of land dealings before being victim of fraudulent purchases (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). In this act, all the documents that had been registered pursuant to the provisions, was in accordance to the land under subject 999 agricultural land leases that had earlier been changed into being freeholds. The Registration of Documents Act only deals documents and the move was borrowed from the Zanzibar system. All the copies to the documents that were in relation to the land transaction activities were to be produced to the registrar to be kept in a deed file (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). The problem with this mechanism was that, it made it difficult for any particular transaction to be related to a specific track of land as the files were haphazardly recorded in an uncoordinated manner. Currently, the Act is applied mostly on coastal regions where the adjudication and determination of claims of individuals to land is yet to be decided by registrar of titles.

2.3.2 The Land Titles Act, 1908 (Cap 282) (LTA)

During its enactment in 1908 as a land titles ordinance, the Act was assigned two distinct purposes. One was to provide a clear distinction between private and public land at the coastal region and second was to track the records of the transaction that are in relation to the land. Accordingly, Act led to the establishment of the office to the recorder of titles who would then facilitate the process of determining between public and private land (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). The rights that would be acquired in this process are grants that supplement the already existing system of rights prior the Act. After the enactment of the land title act (L.T.A) in 1920, the new adjustments to the existing rights were recorded under the RTA Cap 281. The adjudications filled the gap by removing doubts that were in the land titles and also helped to remedy the needed solution for the undermining in the RDA Act. Unlike the RDA, the L.T.A a new system and people could link a specific document to the particular land with the help of distinct folios referring to separate tracks of land (Doshi, et al., 2014; Elliott, 2016; Eck,

2014). As such section 58 of the LTA Act was devised to mandate people into mandatorily registering their certificates or ownership including any other related subsequent document. Failure to register the documents would render them as void in the event that another person had registered their documents against the same land.

2.3.3 Government Lands Act, 1915 (Cap 280)

This enactment came as form of replacement for the crown lands Ordinance of 1915 as it brought about improvements and better provisions of disposition of government and, regulating the leasing and other issues related with land transference and registration. The Act also led to the abolition of the mandatory section where people were forced to register their document in relation to the transaction of non-alienated government land (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). Additionally, the Act states that each track of land that was granted by the government prior to 1920 is to be left leasehold or freehold except for the freehold under the R.T.A or the leaseholds that were converted to the 999 years threshold.

2.4 Registration of Titles System

This system is significantly different from the deed system in the sense that it takes after the Torrens system of registration in Australia (Elliott, 2016). The registration of titles system, just like the Torrens system is designed based on a number of guidelines;

- i. Completeness and accuracy of the document in which the register has to reflect any reasonable doubt of any aspect that is material to the title.
- ii. There must be finality of the register as it will form the source of the entire information concerning the title.
- iii. In the event of an error in the register, any individual who incurs losses of any financial manner, they are to be compensated following the correct measurements of the title.
- iv. The final principle ensures that there is a minimum level of litigation.

All the principles with the exception of the third are embodied in section 3 of the RTA. In this system the primary unit for land registration is the parcel and not the deed in the deed system (Doshi, et al., 2014). Each land parcel is distinguished on a plan or map after cross-referencing with the main register holding the nature of tenure, identity of the current owner and additional auxiliary information. The registration of titles is embodied by the following acts.

2.4.1 The Registration of Titles Act 1920, (Cap 281) (RTA)

The major reason for enacting the RTA was so as to regulate the transactions and also improve the effectiveness of title issuance. The deed system under the LTA, GLA and RDA proved to be unable to ascertain the security of the tenure and land transactions. Under this Act, landowners who registered their documents were conferred an indefeasible title that was secure since the government was the primary guarantor to the ownership (Eck, 2014). As such, all other registration that had taken place in the past would be phased out and all the new transactions carried out under one body of governance. Since re-registering was not made mandatory most land owners chose not to register and it made the three land acts to run in concurrence with each other

2.4.2 The Registered Land Act 1963 (300)

This Act was to take over all the other registration acts and become the only form of registering landowners. According to the act, it contained both the procedural and the substantive law that is in relation to the land registered under the Act (Doshi, et al). The idea was established to create uniformity in land registration that led to the registration of land ordinance of 1959 that nonetheless became the land act cap 300 under the laws of Kenya. Both the RTA and the RLA are retrieved from the Torrens system of Australia, yet the RLA is more detailed and has a comprehensive statute. The RLA embodies its registration on the system of titles which is arguably more advanced when compared with all the other registration acts.

2.5 The process of Land Transactional Activities.

2.5.1 Land Adjudication

This is the initial process of land transaction activities and it entails the ascertainment of the already present land rights and proceeds to identify and endorse that the rights are essentially being enacted. The process does not transfer any rights to the property it just symbolizes that the process of land transaction has commenced as stipulated in the Adjudication Act Cap 284 (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). The main reason for having an adjudication on a piece of land is to verify if the area being declared can be transacted as a single adjudication or it ought to be subdivided to two or additional subsections before transaction (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). Upon approval, the sections are then assigned their own recording

officers and demarcation where the size is dependent on the amount that the team can be able to accomplish within the stipulated time.

2.5.2 Land Consolidation

According to the land consolidation Act Cap 283, it provides the land owners with a practical and solid benefit of bringing together the scattered fragments of the land details. When it was introduced in Kenya, the consolidation process used to be combined together with the adjudication process (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). Conducted with the same officer who conducts the adjudication process, the land consolidation was under the active regulation of the Native land Registration Ordinance which is the current Land Consolidation Act.

2.5.3 Demarcation

After successful adjudication and consolidation, the boundaries of the land are then demarcated by the demarcation officer who is actively assisted with a committee. The committee is then tasked to come up with a report on the parcel of land detailing different sections of concern. The first section had the official name of the landowner, number of parcels, and description of each parcel including the approximate area (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). The second section entailed any lease, encumbrances affecting the land, interest, charge, right of occupation, and description of person(s) who would subsidy thereof. The third section provided details on any individual that deals with the land in terms of interest, lease and right of occupation and any other form of restriction of power of the landowner (Doshi, et al., 2014; Elliott, 2016; Eck, 2014). The fourth and fifth sections respectively entail the name of the guardian suppose the owner of the land is disabled and the date within which the form is completed.

2.5.4 Land Group Representative

According to the land Group Representative Act Cap 287 facilitates the inclusion of groups that have been registered as land owners following the land adjudication Act. Prior to land acquisition, the groups is required by law to convene a meeting in which the members have to come up with and adopt a constitution, elect representatives of between 3 and 10 individuals, and also elect people who will be officers of the group.

2.6 Cadastral Systems

The implementation of a digitized information system that fortifies the registration of lands is referred to as the juridical cadaster. By definition, a cadaster is a detailed register that holds the key details of the actual property of a given country (Dawidowicz & Zróbek, 2014). The cadaster includes information such as ownership details, precise location, tenure, and area or the parcel and value of each parcel of land. For there to be an effective land transaction process, there has to be some form of cadaster. Maintaining a schedule upgrade of the cadastral systems results to numerous benefits for the inheritor or buyer (Dawidowicz & Zróbek, 2014). Some of the benefits include reduced risk of fraud due to certainty of the land owner, reduced land disputes due to boundaries and demarcations, secure tenure, improved conveyance and ability to monitor land market among others.

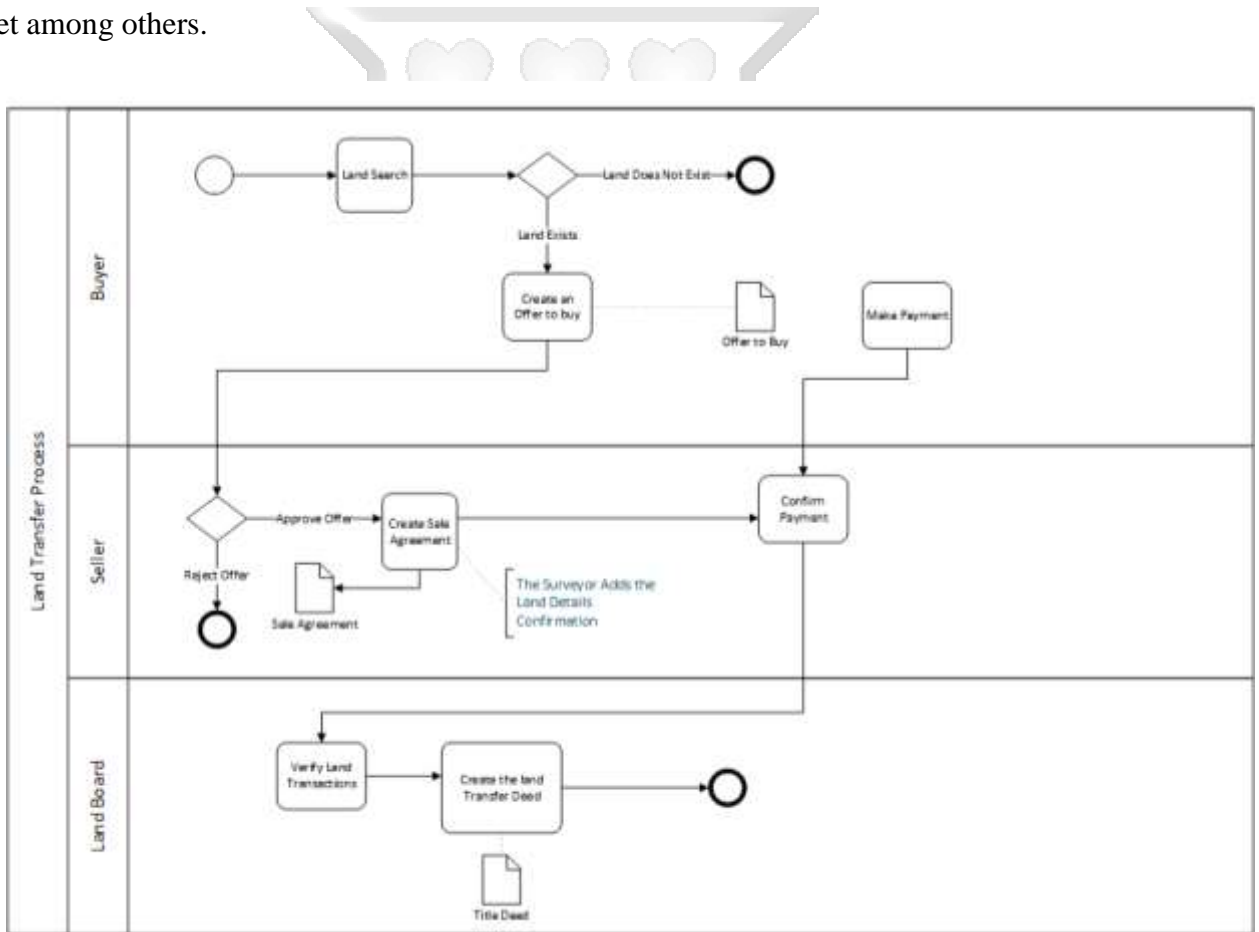


Figure 2.1: Current Land Process

The Current Land Process is divided into three sections; one that involves the buyer, the seller and the Land Commission (Board/Administration). The three groups interact together to generate the key documents; purchase offer, Sale Agreement, and title deed (transfer document).

2.7 Existing Gap

Most of the land in Kenya has been owned by the government and are provided on lease by organizations, private individuals and institutions (Manji, 2015). The accessibility to these lands is still a subject of confusion as it is linked to the aspect of land transactions such as allocation, process of registration and the urban planning as well as land use. In order to implement the regulation on planning, a landowner has to be guided by different documents such as the Master plan, and the Building code. All these aspects are not mentioned in the previous land transaction activities (Lemmen, Van, & Bennett, 2015). Additionally, the literature review does not provide a clear conceptual overview of the security measures that the current system has. As such, most of the documents can easily be duplicated, forged or faked at the expense of the real owner (Elliott, 2016). Additionally, the review lacks comprehensive aspect that requires periodical changed and upgrade the cadaster due to the rapid increase in population and urbanization. New borders are being established all the time, and the system requires constant update.

With the current system, it will require a lot of time before the change is affected (Elliott, 2016). Additionally, for a citizen to access the current system they have to travel to the landscommission headquarters or county land office and lodge a request which will take time (7 to 14 working days) before it is approved (Elliott, 2016). More time (also 7 to 14 working days) will also be spent perusing through the numerous paper work and physical files to locate the exact match that is required (Elliott, 2016). The proposed system looks to significantly cut all the travel expense and waiting time from at least 28 days to an instant feedback by a press of a button. The system will not only reduce the time and offer timely result, but also minimize on document forgery, it promotes transparency as the data are embedded within the network as a whole, meaning they are for public consumption. It will increase security and avoid corruption by distributing the maintenance of records to all parties involved, rather than to a few. The tool cannot be controlled by any single entity and has no single point of failure because the blocks of information are identical across its network.

2.8 Block chain concepts

The concept of blockchain technology lies in its architecture and functionality. By definition, a blockchain can be said to be a digital ledger of transactions void of any corruptible vulnerabilities which can be set to keep record of vital information of each transaction that takes place. The blockchain achieves immutability by time-stamping each series of records that are immutable and is not managed by one computer, rather by a cluster of computers within the chain. The management by the cluster of computers ensures that the information is randomized and secure and the data cannot be lost since it does not have one physical location. To ensure the security of the data, each block of stored immutable data is bound to each other and secured by the use of cryptographic principles in a form of chain (Lang, 2019).

One main advantage is that the blockchain network does not have any form of centralized authority, which makes it a democratized entity. It is shared among different devices with an immutable ledger, anybody that seeks to view and check for the data can access the network and confirms their concerns without compromising its security. The blockchain is then a transparent system in its very nature and each that views or interacts with the system leaves a digital footprint that can be used as identification making it the best tool for tracking transactions (Swan, 2015).

2.8.1 Existing Solutions on Block Chain for Transparent and Secure Land Activities

The Kenyan government uses the issuance of title deeds as a measure of ownership to a given parcel of land. The owner of the land is only identifiable if he is in possession of the title deed that has his details in it. There is yet to be an online system from where a person can visit and ascertain the information on the physical title deed. This move reduces efficiency and motivates blind trust from the buyers.

In other countries such as India, there is also no clear system made for transparent acquisition of titles making it more difficult to know what any person owns. In the Western Capitalist democracies, the system for land registration is depended on complex databases that hold the entire land information from, the size, mortgages, estimated value of the land, land us regulations, taxes and other restrictions. As at 2014 report by The World Bank indicates that it takes at least 24 days to complete a land registration process having gone through all the

transactional activities. Other parts such as south Asia, it requires a minimum of 3 full months (99 days) which is about four times more that of OECD countries.

Some countries such as Sweden have already implemented the use of blockchain in their land registry systems. According to New York Reuters (2016), Sweden had begun tests that would convert the country's land registry system into blockchain. The Swedish government is collaborating with the Chroma Way, which is a Swedish blockchain company and other Telia communication service provider to come with a fully-fledged blockchain based land registry system. As at 2016, they had already implemented a proof of concept using a technical demonstration and white paper of how the system will operate. The technology behind blockchain is that it would create a permanent, public ledger containing all the transaction data that has the capacity to replace complicated systems that depend on a simple on site database.

Dubai is also another country that is increasingly embracing the blockchain technology in its land department (Lang, 2019). Currently, the Dubai Land Department is utilizing a blockchain system to record all the contracts related with real estate, such as lease registration, which are then linked to the telecommunication systems, Dubai Electricity and Water Authority, and related property bills (Lang, 2019). The current system also has a personal database on tenants which contains residency visas, and identity cards which enable electronic mode of payments (Lang, 2019). Accordingly, the government of Dubai has intentions to be the first ever government in the entire world to have implemented all land transactions activities through the blockchain technology by the year 2020.

2.8.2 Application of Block Chain in Land Transactional Activities

Land transactions are supposed to be simple, efficient and allow for the interested parties to view the information later on in cases of selling or buying. Recording and viewing of information on the blockchain network does not require transaction fees. Once the system has been set up, the blockchain becomes an ingenious yet simple mode of sharing information from one entity to another in a secure and fully automated manner. In the case of land transactions, blockchain would reduce the elements of fraud, forgery and other disputes that are in relation to land transactional activities (Keith, & Babs 2018).

In order to achieve the immutable nature of land records, the registrar of lands would initiate the process by assigning the said land through creation of a block data. Before storage,

the information is verified by the thousand and sometimes millions of computers that are scattered all over the internet. The verified and time stamped block of information is then attached to a chain and then stored all over the internet. This process not only creates a record that is unique and immutable in nature, but also creates makes the record to have a unique and verifiable history or transactions. With this architecture, is nearly impossible to tamper and falsify any one record since it would require altering with the whole chain of millions of instances of the same data (Keith, & Babs 2018).

2.9 Conceptual Framework

As evidenced from the literature, existing systems fail to deliver the needed security measures for immutability of data. In the proposed system, the three stakeholders that is landowner, buyer and government agency will be served based on a Smart Contract system. The system will allow the landowner and the government agency to begin a transaction of any kind relating to land issues. The initial transaction will be conducted within the transactional block. At this stage, the buyer and the seller after deciding to transfer ownership of the land will use the services of the Smart Contract where they will be assigned a surveyor agent. The details of this transaction (name and other identification details) are recorded in the Identity Management Authority (IMA/IM). The smart contract would then be responsible of compiling information from the landowner, buyer/inheritor, survey agent, and the settlement agent to formulate a tentative certification that would be sent to the Certification Authority. With the help of a crypto generator block transaction, the information from the smart contract and that from the certification Authority is generated and stored in a Hyper Ledger for storage purposes (Goldman 2016).

This study's conceptual framework is based on block-chain model. There are different stakeholders in land transactions including Landowners, buyers, government, and land department. The model is based on a distributed immutable ledger of transactions. The tool will have the following components; Identity Management Authority, Distributed Ledger, Cryptographic encryption, Verification Models, smart contracts and Certifying Authority.

The Identity Management Authority (IMA) is important to the tool as it enables verification of the different parties and stakeholders in the land transactions. IMA ensures the landowners, buyers, agents, and other institutions are who they say they are. Its primary function

is to allow for acknowledgement of the users on the system. The IMA uses the government information and documents to verify stakeholders.

The distributed ledger is a collection of independent databases that store the immutable data from the different transactions. It forms part of the security and transparency to allow for storage of the land transaction chains. The ledgers contain the encrypted transaction blocks (transaction key).

Cryptographic encryption ensures the generation of an encrypted key based on the transaction and continually builds on the previous transactional blocks. Once the block is encrypted, the block and its encrypted data are sent to the ledger and shared across the other nodes.

Verification Models function is to ensure the verification of the blocks checksum and verify the transaction chain has not been broken from the previous transactions. The verification models work together with the smart contracts and the Identity Authority to ensure the transactions and checksums integrity (Goldman 2016).

The certifying authority primary function is to issue a certificate on completion of the process, which can be used to confirm the chain of history of transactions on the block. The Certificates offered should contain the checksums, key, and details of the transacted property.

In order to ensure flow of information across the different stakeholders, different smart contracts are issued and approved with each party to approve a transaction. The contracts are part of contribution to the blocks approval and verification.

During land transfer, the buyer/owner issues a transfer request. The transfer request is a smart contract that details the buyer/inheritor details. The contract is then signed by the buyer to confirm land transfer. On approval, the system initiates a verification request through the payment details. The payment confirmation request generates another smart contract with details of payment. The details are confirmed by the payment agency such as bank or any other financial institution. The financial institution should exist on the Identity Authority. On confirmation of the payment details, a third contract is issued for confirmation by the Surveyor who is an agent on land distribution and availability of the land parcel. The Surveyor provides documents to support the smart contract on land estimates and confirms its physical valuation. Once

confirmed, a fourth smart contract is generated for the settlement agent who must be verified by the identity authority. The settlement agent confirms the previous details and sends them to the Lands department for certificate generation. These activities are chained as part of the land transfer block and they help in building the verification of the process.

The certification authority confirms the land transfer and splits the land in accordance to the approval from the surveyor and settlement agent. These blocks are then stored in the distributed ledger with checksums for confirmation.

These transactions are made available, and when a buyer wants to confirm the land ownership, they input the title deed number, which shows the various transactions and current owner of land. These processes also ensure there is no dependence on one party for land processes, and the verification models work to ensure different parties approve the process.

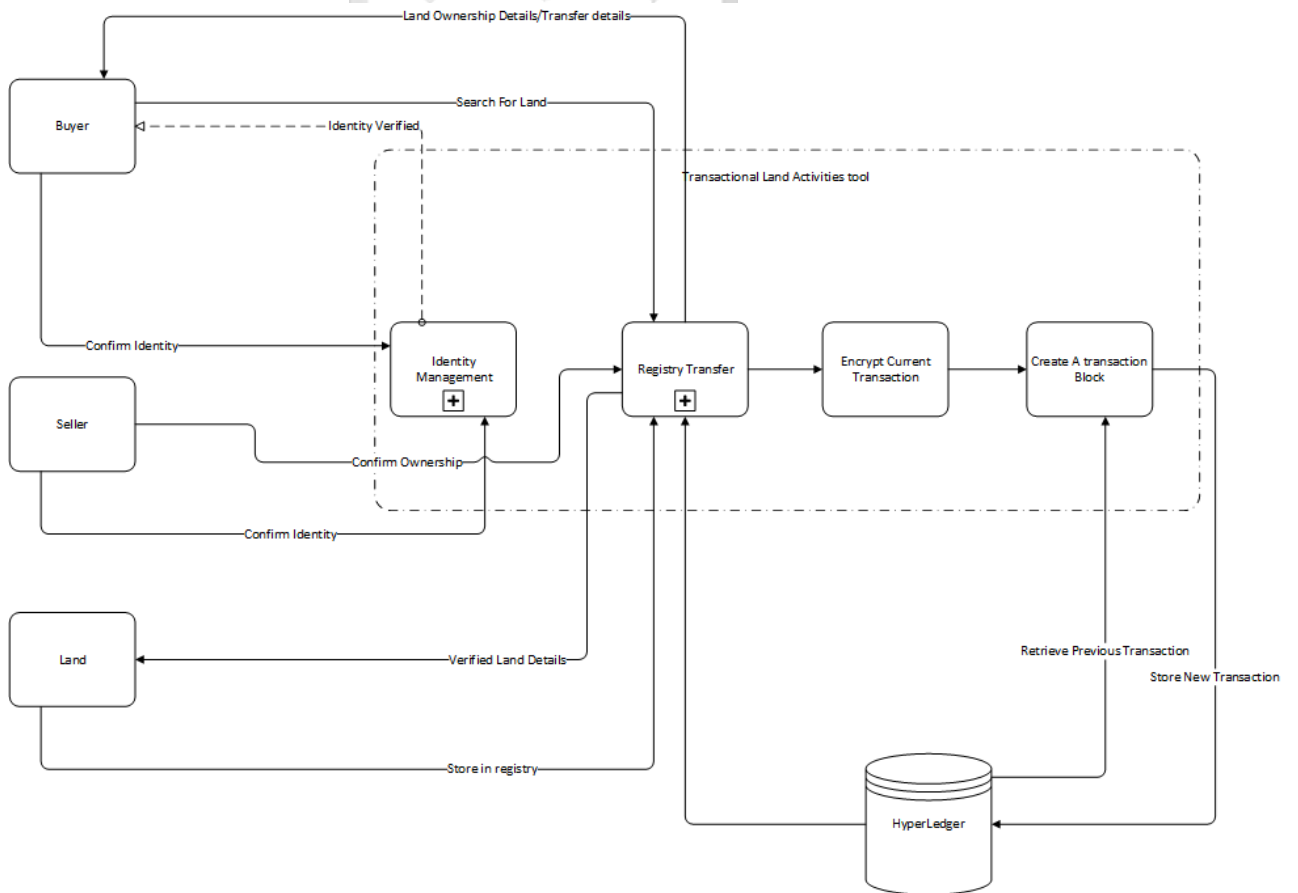


Figure 2.2: Conceptual Framework Diagram

Chapter 3: Research Methodology

3.1 Introduction

This chapter offers a detailed overview of the different methods and forms of data collection by introducing the strategy of the research and the techniques that was applied to achieve the said strategies (Kumar, 2019). The chapter provides an outline of the overall research approach that was used as well as the method and sources of data collection.

3.2 Research Design

The research design referenced the entire mode of strategy that was chosen incorporated the varying components of the research into a logical and coherent manner (Roller, &Lavrakas, 2015). The research design would then ascertain to the effective address of the problem statement since it has the primary blueprints off the identification, observation, collection, measurement and finally analyzing the sampled data (Roller, &Lavrakas, 2015). There are many commonly used research design methods, however, this section will limit the analysis to the one used in the analysis and design of a tool to track land transactional activities.

3.2.1 Mixed Research Design

The issue of land deals three main entities which are land owners and buyers, government and the land itself. Descriptive research design will help in the research by providing the needed answers to who, where, what, how and when questions that are associated with the tracking of land transactional activities (Jagtap, 2015). This is important because the researcher will be able to study the process of the land transactional activities, identify the challenges in the process and therefore develop a solid well founded solution. With the help of descriptive design, the researcher will be able to acquire relevant information in regards land processes. Additionally, the research design will applied research which involves a scientific approach that seeks to come up with a viable solution to a given practical problem (Schabenberger, &Gotway, 2017). The land transaction tracking system is based on innovative technology; accordingly, applied research would help associate the problems with innovative solutions that could be implemented to solve the problem. Applied research help in coming up with systems that would have human interaction and ensure that it runs effectively and the data is secure and immutable (Schabenberger,&Gotway, 2017). The applied research design follows a predetermined set of stages from the time the problem was observed until its solution is executed and applied. The

figure below provides a summary of the stages present in the applied research design and how they are used from each stage to another to achieve a viable executable solution. Applied knowledge on how human beings interact and knowing the foundation on how the internet operates can be helpful when designing a system that is based on the internet and is to be used by people of different kinds regardless of their intentions.

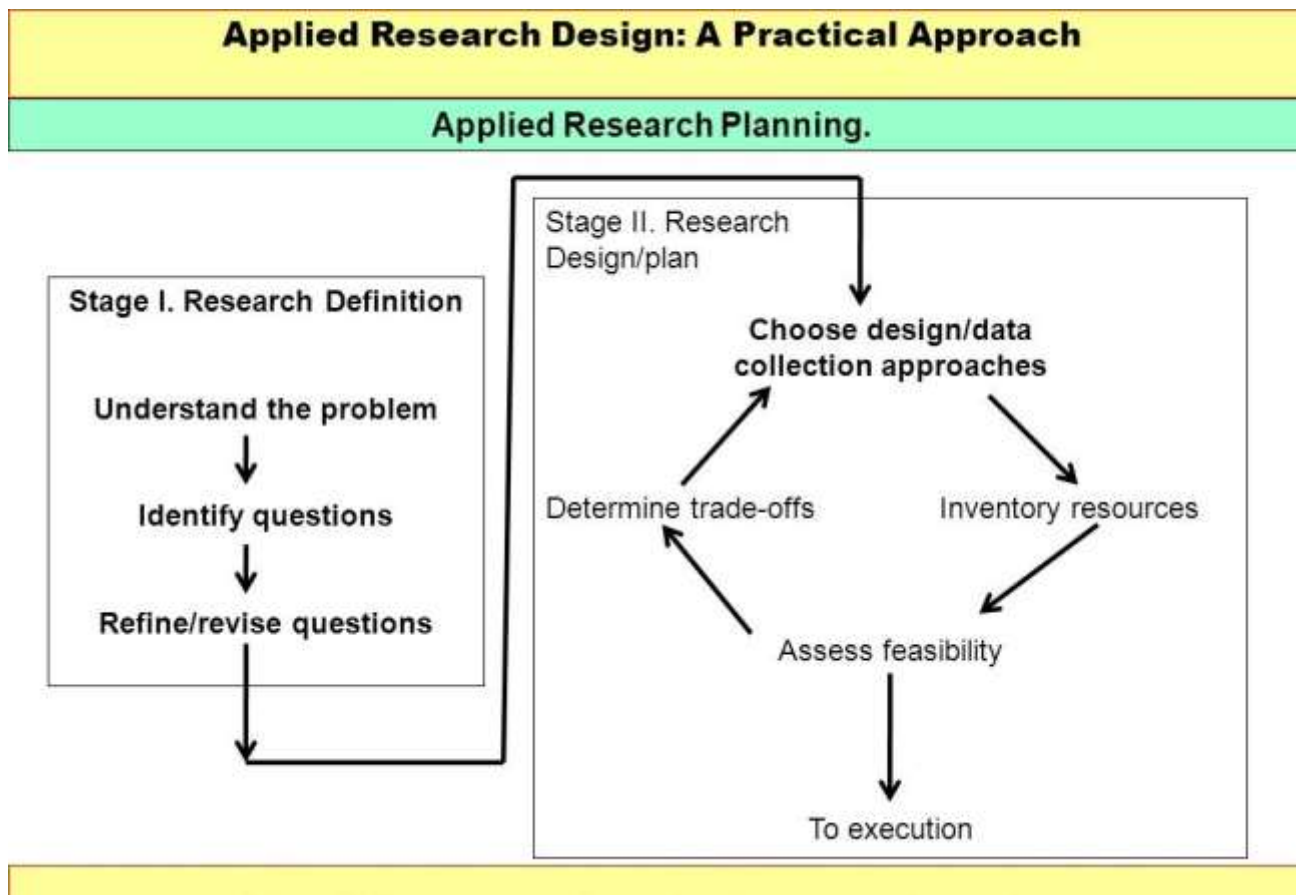


Figure 3.1: Applied Research Design

(Schabenberger & Gotway, 2017)

3.3 Population and Sampling

The operation of the system will be done by the government of Kenya through its ministry of lands (Handcock, Gile, & Mar, 2014). This reduces the sample size from the whole country to a few chosen departments within the land sector. Among which includes the land registrars, surveyors, and some knowledgeable employees, administrators of the current system, land owners and buyers. The identification and participation of the respondents will be based on a

convenience non probability sampling selection model (Handcock, Gile, & Mar, 2014). As the researcher is limited by money constraints, time and the ministry workforce, it becomes practically impossible to sample the whole population of the ministry and associated land owners (Handcock, Gile, & Mar, 2014).

3.4 Data Collection Methods

These are a representation of the different tools that the researcher will implement in order to gather primary data (Cope, 2014). The data collected will then be used as the emphasis for drafting recommendations and drawing conclusions. In the case of primary data, the researcher will collect the data using the following means of collection:

3.4.1 Questionnaires

This will be a prewritten set of questions intended to gather specific information on given topics of research from one or more individuals (Cope, 2014). To enable ease of access and retrieval and anonymity of data, the questionnaire will be administered on an online platform. This will not only cut on the cost of travel for the researcher, but also make it easier for the respondents to access and respond to the online questionnaire at their convenience (Cope, 2014). The questionnaire will be provided to the people who possess a direct involvement with the study in order to attain the objectives of measuring the polls, opinions and the overall point of view of the respondents. The questionnaires will then be structured to have both close and open-ended questions for quantitative and qualitative data respectively (Cope, 2014). This will then provide the researcher with a wide array of comprehensive information based on the objectives of the research.

3.5 Data Analysis

The analysis of collected data consists of the overall examination, tabulation and categorizing as well as combining all the collected evidences in order to effectively address the proposition of the research (Chambers, 2017). The data retrieved from the questionnaire are analyzed using the open coding technique which incorporates an extensive process of comparative analyses, examining, conceptualizing, comparing, and categorizing data into a more presentable manner. The essence of open coding is to provide the researcher with patterns or trends through classification and categorizing in order to discover and draw conclusions (Chambers, 2017). Codes are generated as the researcher analyses through each data set from

both primary and secondary sources by separating dominant themes that keep on appearing in the data transcripts (Chambers, 2017). After the codes have been successfully awarded to the different segment then moves to categorize and group the related codes and given a name using the codes as a guideline (Chambers, 2017). The saturated data will then be analyzed using descriptive statistics and the results represented as percentages and frequencies using different presentation formats (charts, tables and graphs).

3.6 Research Quality (Validity and Reliability)

Research instruments are only valid based on the extent with which they are able to measure what they are intended for. Validity in this case is the meaningfulness and accuracy of the interfaces basing on the collected information. It also refers to the amount within which the results received from the examination of the data are the actual representation of the variables of study. This research looks to validate its instrument through content validity (Creswell,& Creswell, 2017). Based on the content relatedness technique, there will be a measure of the degree of which the questions being asked are a reflection of the area being studied. The research methods will also be tested for reliability using varied instruments that are used to test and re-test the techniques being used.

The instruments have to satisfy the Cronbach's coefficient of reliability (Bonett, & Wright, 2015). This would mean that a coefficient correlation that is higher than five (5) will be an acceptable response since it is reliable (Bonett, & Wright, 2015). The research methodology will only ask the relevant questions that are inclined to answer and provide solution to the problem statement (Bonett, & Wright, 2015). This way, the researcher will have met the objectivity of the research study. Given that the relationship between the researcher and the respondents is usually sensitive in nature and safeguards ought to be placed as a measure of ethical consideration (Creswell, & Creswell, 2017). Any information that is given to the researcher during the study period should be held with confidentiality for primary data and appropriate referencing for secondary information.

3.7 System Development Methodology

The development of the system followed the Rapid Application Development (RAD) methodology which focuses on development of applications over a short period. This hastens the development cycle resulting in the development of quality products in a more efficient and cost-

saving manner. The RAD development model have phases such as analysis, design, building and testing distributed into a series of short and iterative development cycles as shown in figure 3-1. The lifecycle of the methodology comprises of three stages that are requirements planning, user design, rapid construction and transition.

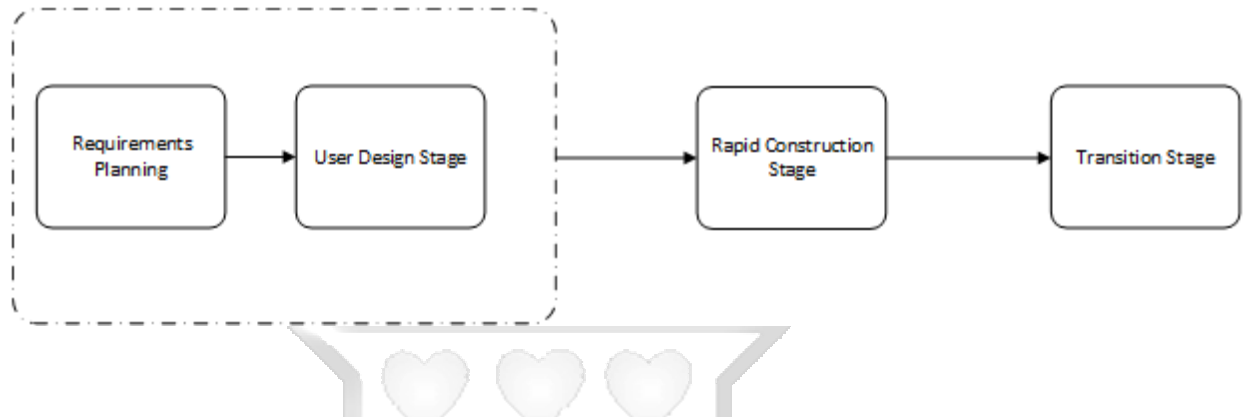


Figure 3.2: RAD Development Methodology

a) Requirements Planning Stage

This stage entailed collection of relevant data on the land registries, published documents such as Journals, newspapers, books, articles and government publications. These documents will provide a clear understanding of the land transactional activities.

a) User Design Stage

This stage entails the design of the prototype and architecture of the proposed solution. There will be the design of Unified Modeling Language (UML) diagrams to describe flow of information and interaction of the different system components. An application used in drawing the use cases, class diagrams, and sequence diagrams and data flow diagrams was Visual Paradigm 14.1.

b) Rapid Construction Stage

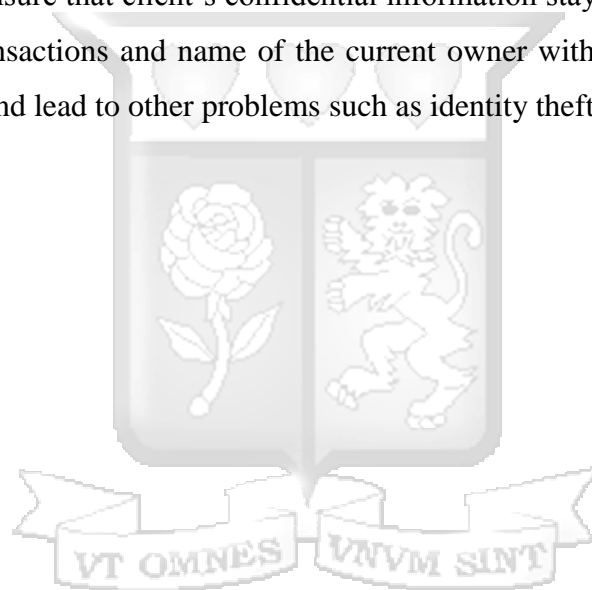
This stage involves the implementation of the model following the information in the user design stage. The development language used will be Python. This will then be followed by testing and validation of the proposed model through conducting of experiments.

c) Transition Stage

This stage follows the implementation and testing tasks with the prototype model being deployed for a tool for tracking land transactional activities. It also encompasses development of user training plans and documentation for the prototype users.

3.8 Ethical Consideration

The system was implemented based on the foundation of ethics and societal morals. For instance, the immutability of data provided by the Blockchain framework allows for the system to be made accessible to the public and easily accessible. The researcher also built codes that do not go against any policies. The system is then transparent in nature and upholds the highest degree of integrity. To ensure that client's confidential information stays hidden, the system only displays the relevant transactions and name of the current owner without necessarily having to provide all their details and lead to other problems such as identity theft.



Chapter 4: Data Analysis, System Design and Architecture

4.1 Data Analysis

The primary objective of this study is to come up with digital tool to track land transaction in activities at the land registry of Kenya. This research based its method on descriptive analysis where in both defining the problem domain and also in the design of the solution domain. The chapter is aimed at the analysis of collected data and with it device a design prototype to facilitate projects section. In retrospect, system design entails a definitive process that incorporates the wholesome description of the structure, components and interface of the system that would satisfy the requirements of the users and bridge the gap from the previous systems. The chapter then discusses the aspects of data analysis, system analysis and system design in a more detail spectrum.

4.1.1 Results from Questionnaire

An accumulative total of 100 questionnaires were sent to the various stakeholders; key personnel at the ministry of lands and to some land owners who accepted to take part on the study. Of the 100, only 88 were able to fill the questionnaire and send back for analysis. This was represented with an 88% response rate while 12 percent of the respondents cited having a busy schedule to respond to the questionnaire. The table below provides a representation of the response rate based on the questionnaire.

Response	Frequency	Percentage
Total Respondents	88	88%
Total of those who did not respond	12	12%
Total issued questionnaires	100	100%

Table 4.1: Response rate to the questionnaires

The information from the table was then graphically represented in a pie chart as shown in figure 4.1.

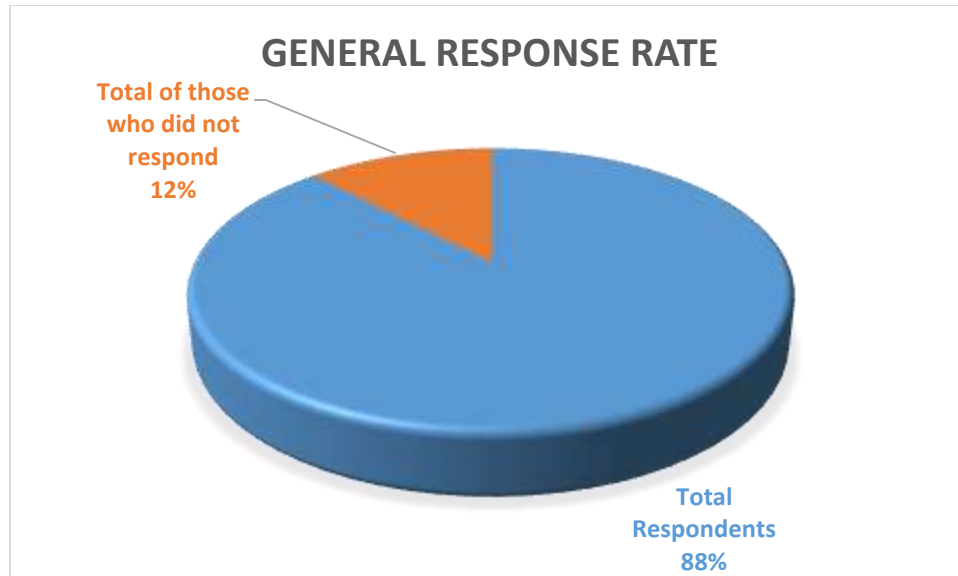


Figure 4.1: General Response Rate

4.1.1.1 Stakeholders Response Rate

Of the 88 individuals who responded, 70 (79.5% of the respondent) were directly associated with the ministry of lands as employees and senior official while 18 (20.5% of those who responded) were random landowners who have in one way of another used or interacted with the current system at play. The graphical representation of the data is as shown in figure 4.2.

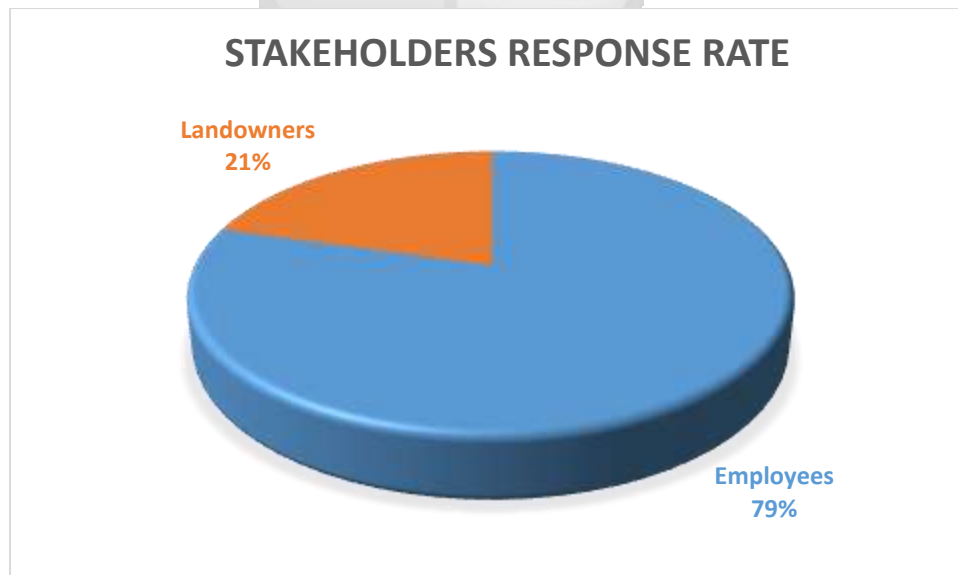
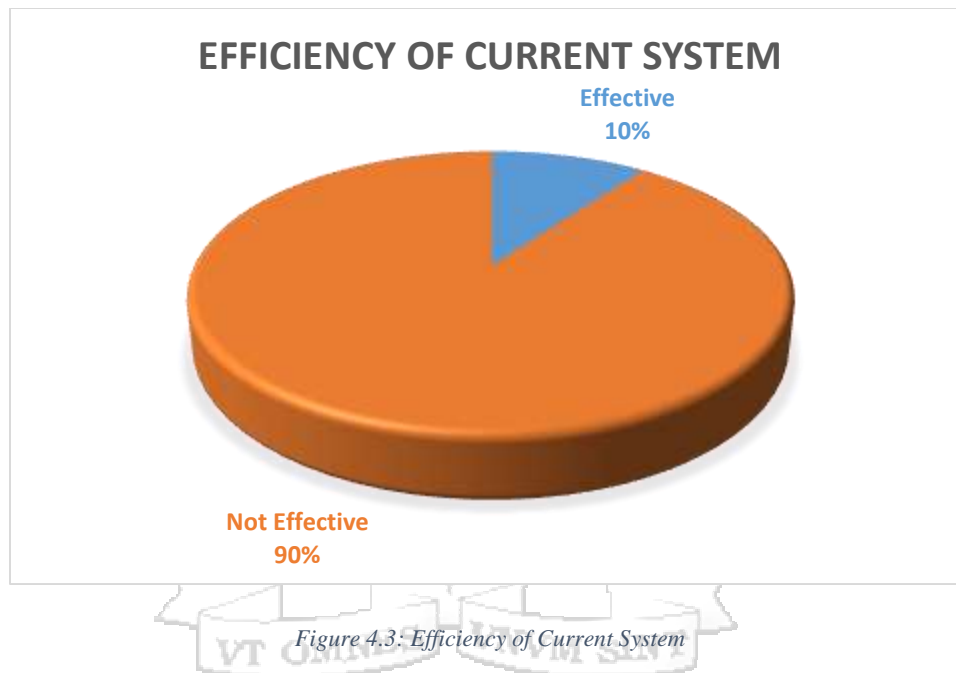


Figure 4.2: Stakeholders Response Rate

4.1.1.2 Efficiency of Current System

90 percent of the respondents ascertain that the current land transaction process is tedious and contains a lot of steps that are not recorded at a centralized location. And as such, there is always long queues experienced on busy days on some actions that can be implemented with a press of a button. The only form of confirming that a step was achieved is by presenting the final certificates and documents to the LCB offices. Most of the employees cited problems with locating old files while landowners cite problems with long queues and information misappropriation



4.1.1.3 Security of Data

The security of the data in the land registry offices was a subject of contention as 37% cited that the data was secure and hardly accessible by unauthorized personnel. Whereas, 60% said that they don't have faith in the ability of the land registry to secure their data and maintain immutability with the current system. The remaining three percent were uncertain of the security of the process. The data is shown in the figure 4.4.

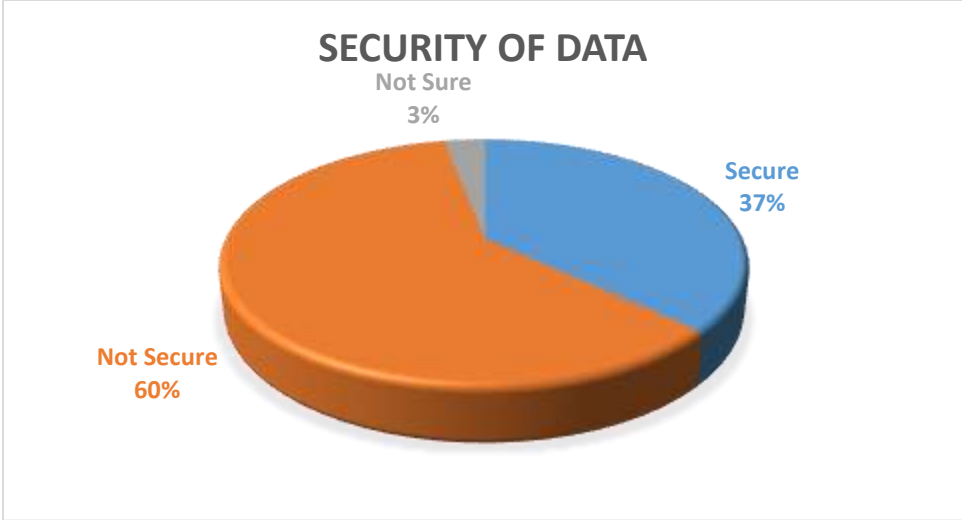


Figure 4.4: Security of Data

4.1.1.4 Challenges with the Current System

There are several challenges that the land registry department is facing that are experienced by both employees and landowners in equal measure. Since they interact directly with each other most of them encountered including 36% on mutability of data, 28% undocumented ambiguous data, 22% had problems with untimely feedback, 10% inefficiency in coordinating land transactions, and 4% unnecessary payments for government services. The data is represented in the figure 4.5.

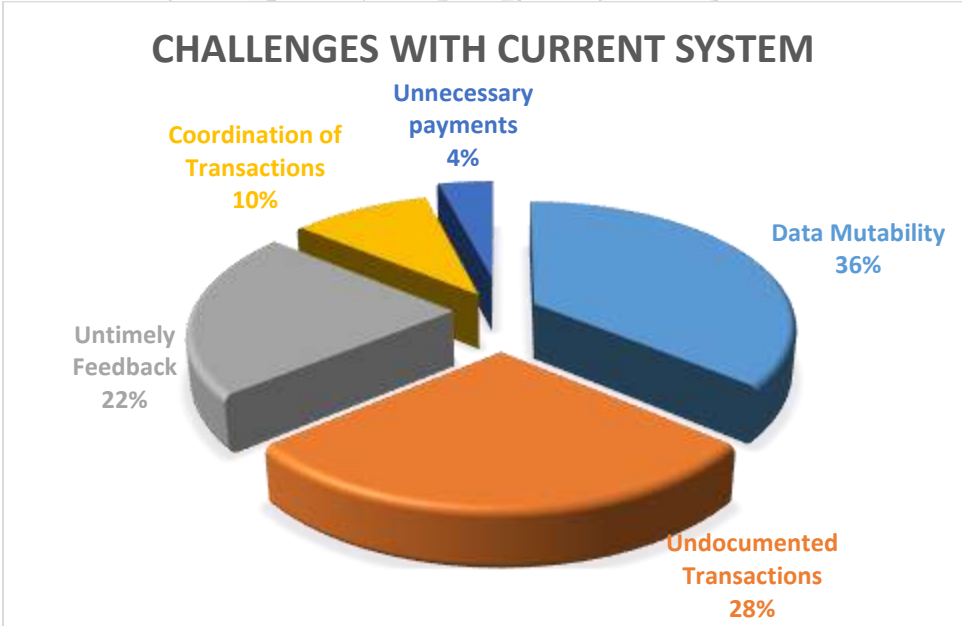


Figure 4.5: Challenges with Current System

4.1.1.5 Rating the Current System

After reviewing the challenges with the system in play, the respondents were asked to review the system basing on the scale of Excellent, Very good, Good, Fair, and Poor. Majority of the respondents of up to 47% ranked the system as fair, followed by a 39% who considered the system to be poor. The rest of the ranking had 10% good, 4% very good and 0% Excellent. The data is illustrated in the figure 4.6.

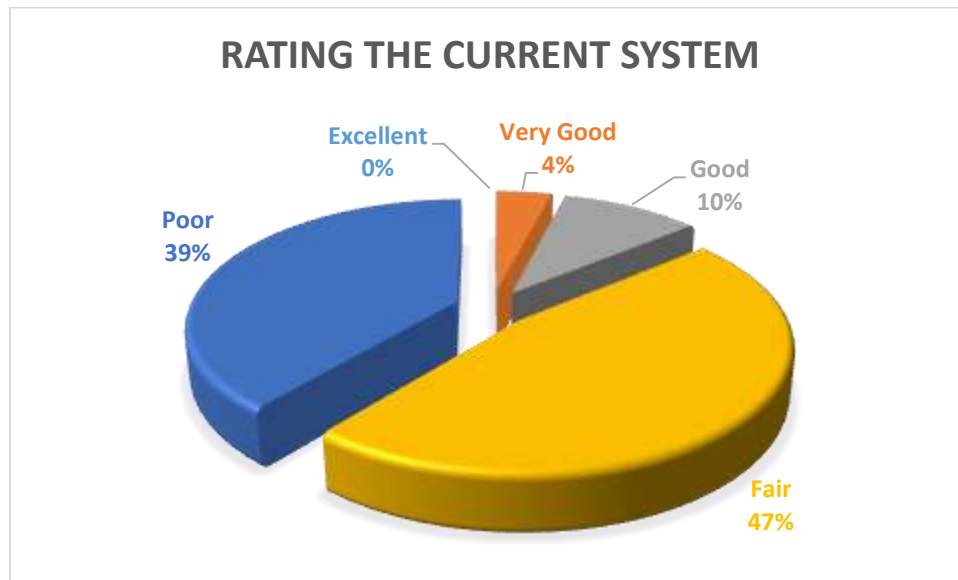


Figure 4.6: Rating the Current System

4.1.1.6 Necessity for a New System

The questionnaire also asked to get the views of the respondents on whether there is need for a new immutable and digital tool to track and keep record of land transactional activities. Both the land registry personnel and the landowners advocated for a new system.

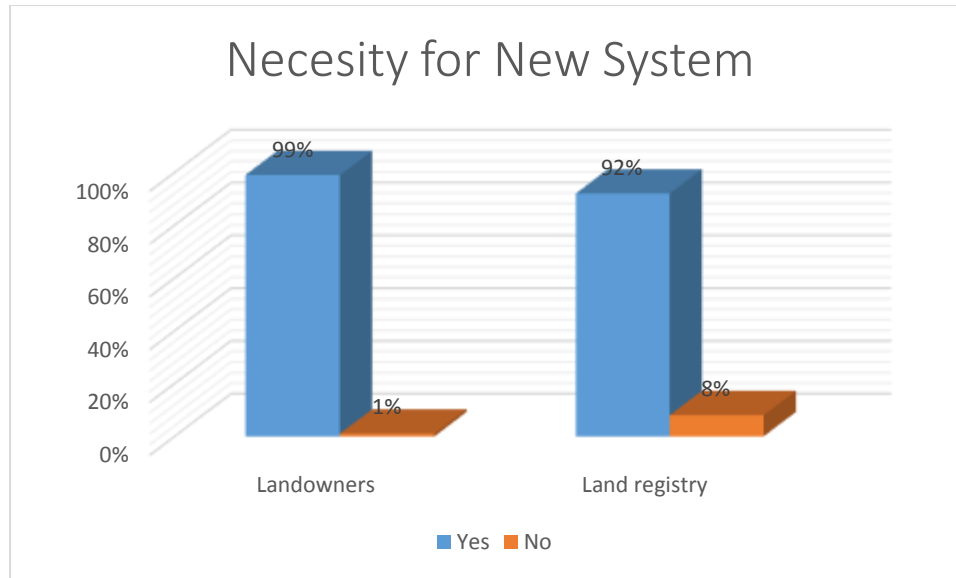


Figure 4.7: Necessity for New System

4.2 Requirement Analysis

From the results obtained during the study, it was evident that the respondents were in need of a tool that would facilitate efficient tracking of land activities from identification up to the final step of issuance of new title deed. The proposed system should be secure, immutable, efficient and should allow for coordination of the different bodies that govern and oversee the issuance of land and title deeds. Based on the primary data and other secondary sources, requirement analysis is divided into three subsections: user requirements, functional requirements and non-functional user requirements.

4.2.1 Functional Requirements

These requirements entail the operations, manipulations of data and other processes that the system must deliver at any given time. Just to mention a few, functional requirements must meet the description of the type of data to be fed into the system, the people authorized to alter or enter data into the system, description of system output at different user levels, and operations performed to ensure each transaction is tracked. For the selection of the project's prototype, the functional requirements include the following:

- i. Identity Verification of the system actors
- ii. A system that would keep records of every transaction in the land exchange process
- iii. A system that would ensure data remain immutable

- iv. A system that shows detailed transaction details of all land activities
- v. A system that allows prospects land buyers and owners to check the status of their land
- vi. A system that can reduce the transaction time from the long waiting days.

4.2.2 Non-Functional Requirements

These requirements are not necessary for the operation and functionality of the system but are mandatory for the system to have and can be used to judge the operability of the system and privacy of confidential or sensitive data.

- i. Security
- ii. Scalability
- iii. System performance responsiveness
- iv. Data integrity through immutability
- v. Ease of maintenance and debugging.

4.3 System Architecture

The proposed solution relies on the technological advancement of block chain and how they it ensures immutability of the system in proving transactions. We have separated the system into three main layers; the Identification and Verification Layer, the Certification and Approval Layer and Finally the Block Chain store layer.

4.3.1 Identity layer

The identity layer is the outermost layer facing the users. It is at this layer that the system verifies who should access the system and what they can do. The system relies also at this point on the Government issued documentation to verify persons of interest; buyers, sellers, institutions, Legal Advisors, settlement agents, and Land Board Authority. Once a user has been allowed into the system, the verification and permissions identify the tasks a user can action on. It is at this layer that we ensure the users do not have conflicting information to be able to commit all transactions by themselves.

4.3.2 Certifying Layer

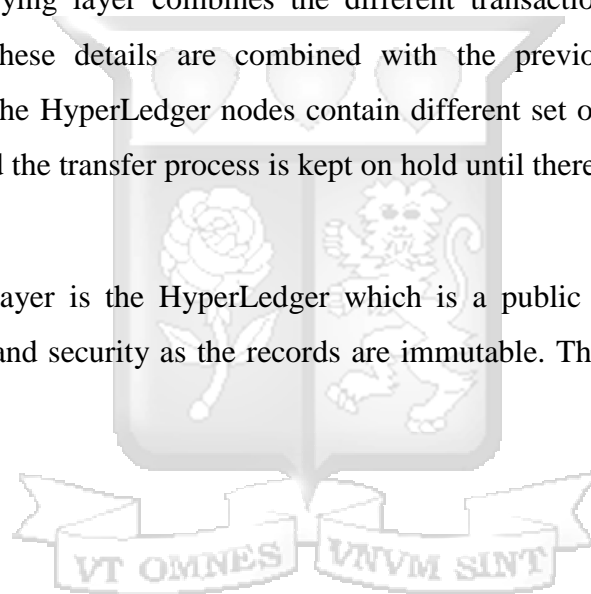
After identification, we have the certifying layer. This layer allows creation of the different smart contracts between different parties using the system. It is through this layer that the buyer puts the request on the land details they would like to purchase. The details are then verified against the lands registry system. The system counterchecks from the hyper ledger the

details of the land and notifies the seller (Owner of land). If the seller accepts the offer, a sale agreement document is created, which is kept open for approval with confirming documents from the surveyor, legal advisor and settlement agent. The three ensure the sale agreement has the proper details on payment, land details and expectations. The system keeps the contract open until a document confirming payment has been updated on the system. Once the payment is confirmed, the system alerts the Land commission with the encrypted offer and sale agreement with all supporting documents from each party. The commission, review the together with the registry in case the property wasn't previously listed, otherwise the system prompts approval of transfer. Approval of transfer by Board generates a transfer document.

The certifying layer combines the different transactions and creates a hashed block of transaction. These details are combined with the previous transaction from the HyperLedger. If any of the HyperLedger nodes contain different set of information, the current transaction is flagged and the transfer process is kept on hold until there is a sync of information.

4.3.3 Hyper Ledger

The last layer is the HyperLedger which is a public blockchain database that allows for transparency and security as the records are immutable. The details on design are as shown figure 4.8



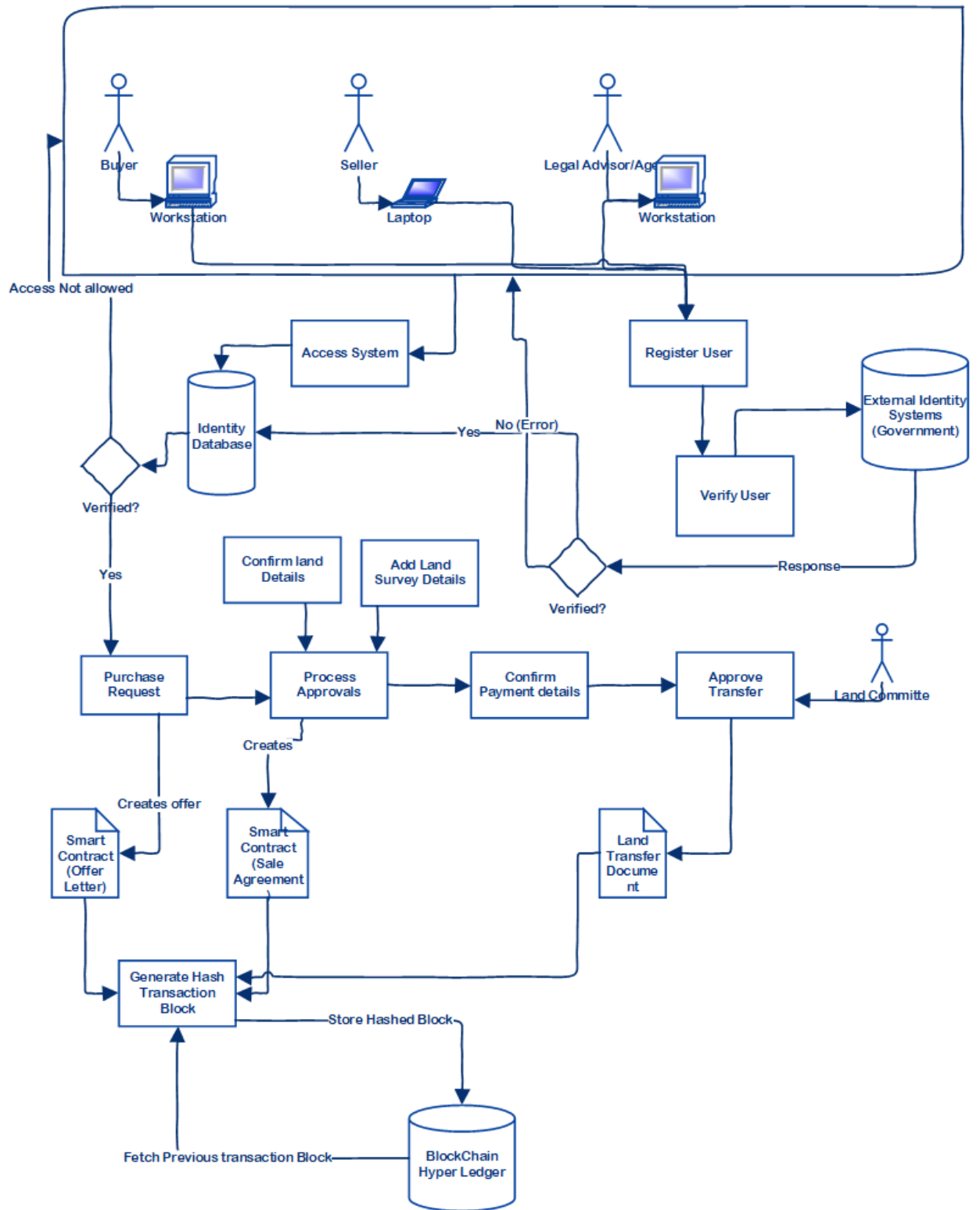


Figure 4.8: System Design

The system design shows the interaction of the different actors with the system processes and levels. The External Government system is to ensure the actors are accurately verified by the national registrar of people. It also integrates to the KRA system to verify user with the tax payer since it is a requirement for any land transaction. The tool interacts with the user and the Blockchain database to ensure the immutability of transactions and recording of each individual land transaction.

4.4 System Design

The system design is a detailed expectation on how the system is expected to behave. It details the information flow across different components and actors of the system. It is through the design that the requirements are validated. It also ensures that the user expectations are met and the information flow is updated as required.

There are various documents and diagrams used to depict the design of the system. These include use cases, data flow diagrams, Entity-Relations diagrams, sequence diagrams and the Partial domain model.

4.4.1 Level 0 Context Level Diagram

The Level Context Diagram (Figure 4.9) depicts the different entities and how they interact with the system. The key players include the Buyer, seller, Land Administrators and the HyperLedger to store the transaction chains and blocks across its nodes. The diagram below shows the interactions of the different entities.

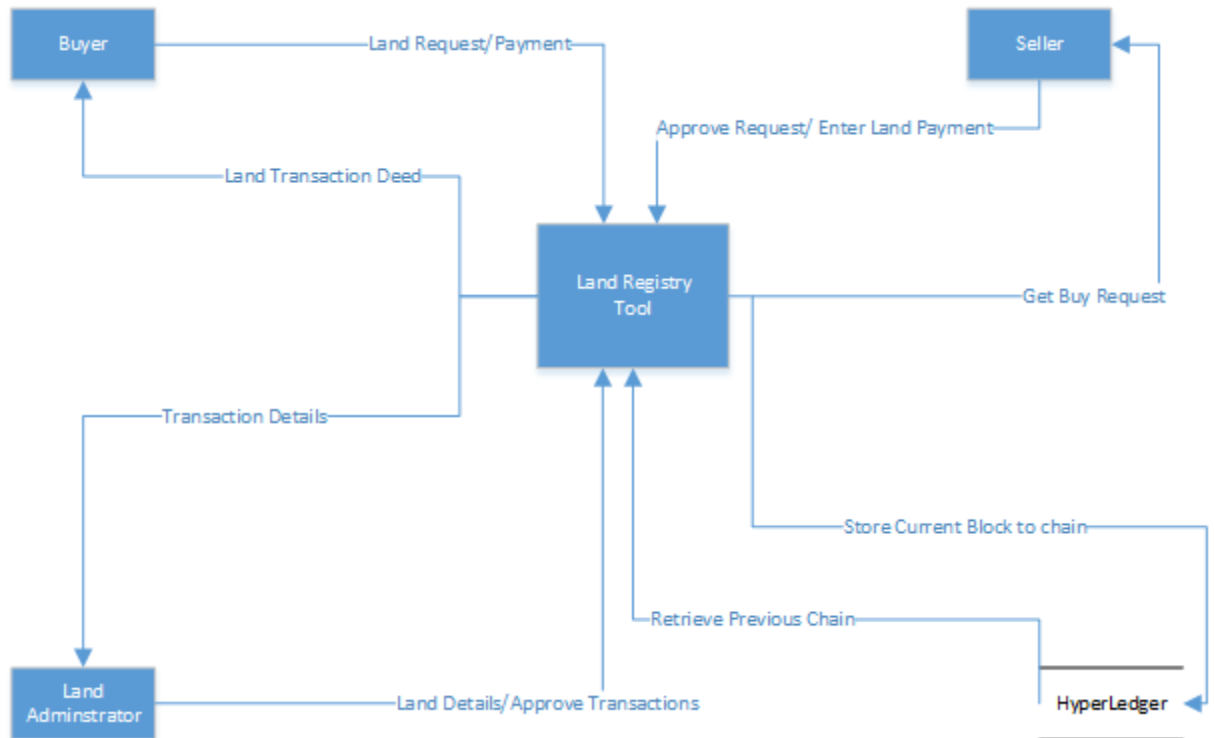


Figure 4.9: Context level Diagram

4.4.2 Level 1 Data Flow Diagram

The data flow diagram (Figure 4.10) shows the interaction of information across the different components in the system. The information flow is dependent on the actions of the buyer and seller, which at the end are used to confirm the generation of the deed certificate and the generation of the users transaction in certificate generation.

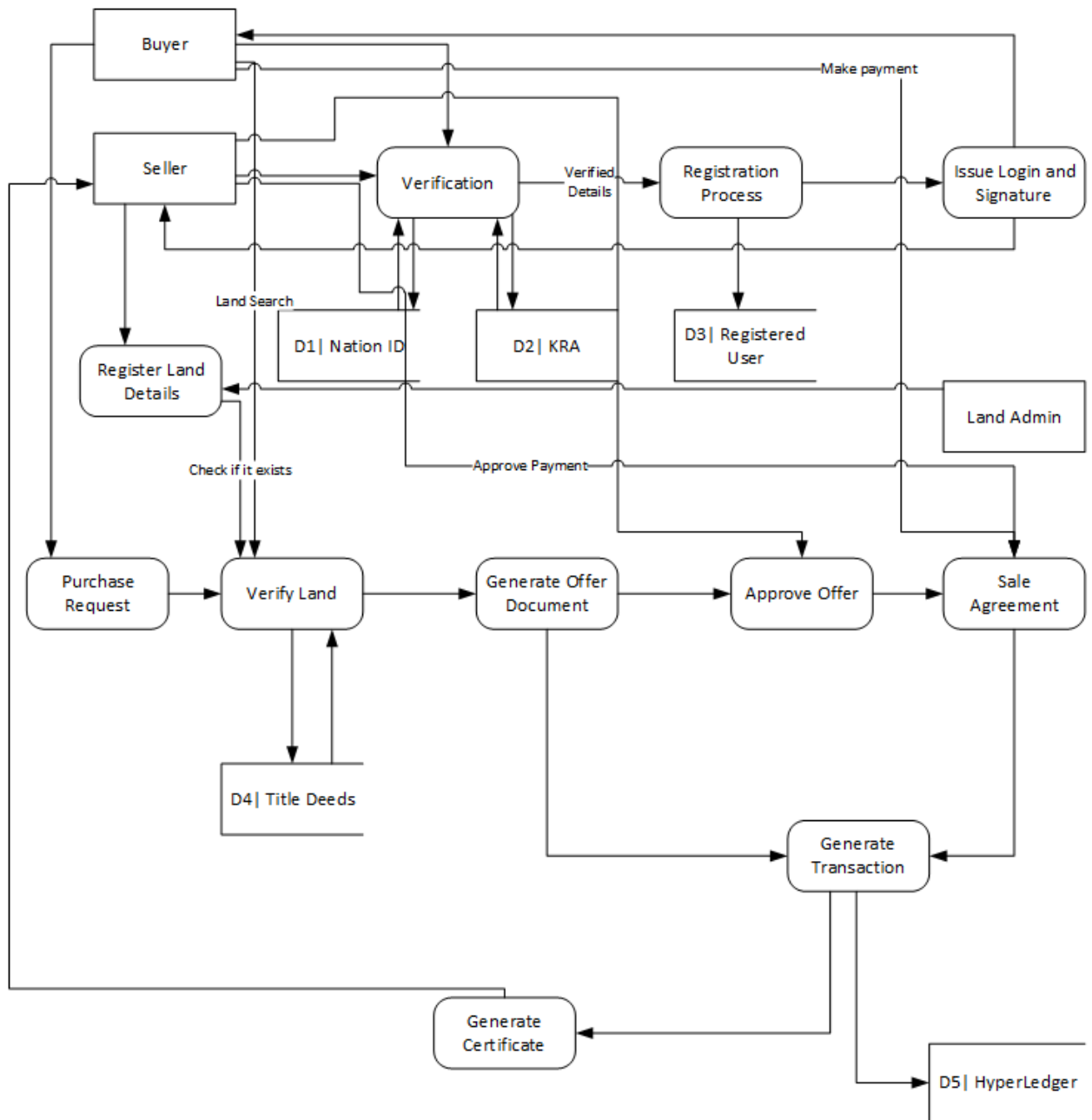


Figure 4.10: Data Flow Diagram

The level 1 DFD shows the different entity models and their interaction with the different system processes. The system entails access to different databases that are kept as blocks of hashed information for use as a verification standard. The system ensures each entity is able to interact with system processes at different levels to ensure a blockchain data consensus and approval of transactions.

4.4.3 Use Case Models

A use case is a diagram that shows the interactions between different actors (users) and the system with objective to achieve a given goal. They are mainly used to depict the functional requirements into the system.

4.4.3.1 Admin Use Case

The land administrator is responsible for most of the transactions in the system. In order to ensure independence of work, the case model assumes, the land registry has been updated buy the land ministry in this case. Hence, the function of the administrator in this case is to ensure the processes from the buyer and seller work in accordance to the set processes. The use case for the process is as described in figure 4.11.

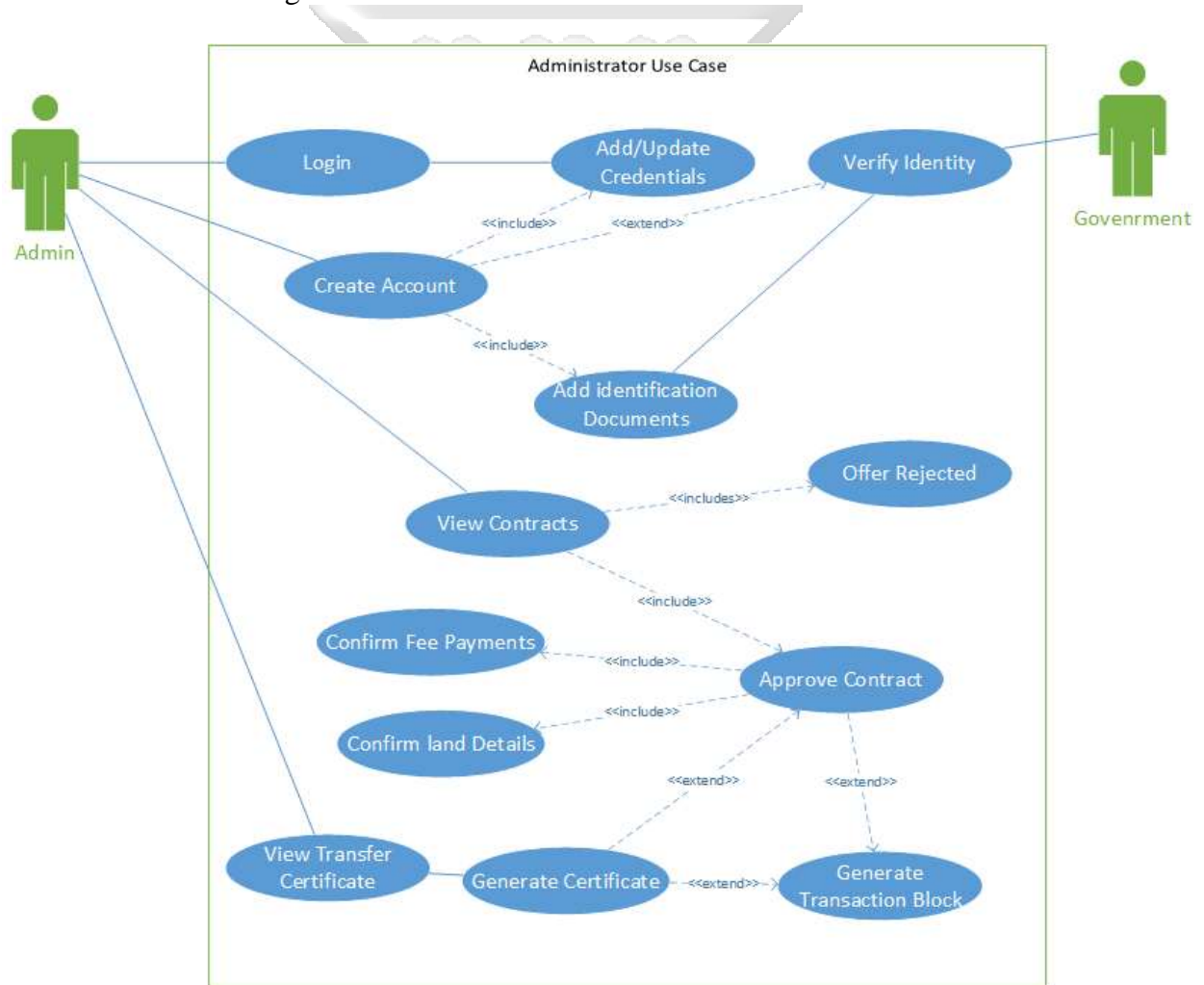


Figure 4.11: Use Case diagram

4.4.3.2 Seller/Owner Use Case

The current implementation focuses mainly on the land transfer process and how the process can be made secure. The Land owner ensures the land registry is updated accordingly to their land details. They work together with the legal team/settlement agent to ensure the Land details are documented as required and the land transfer contracts meet the expected valuation and are correct.

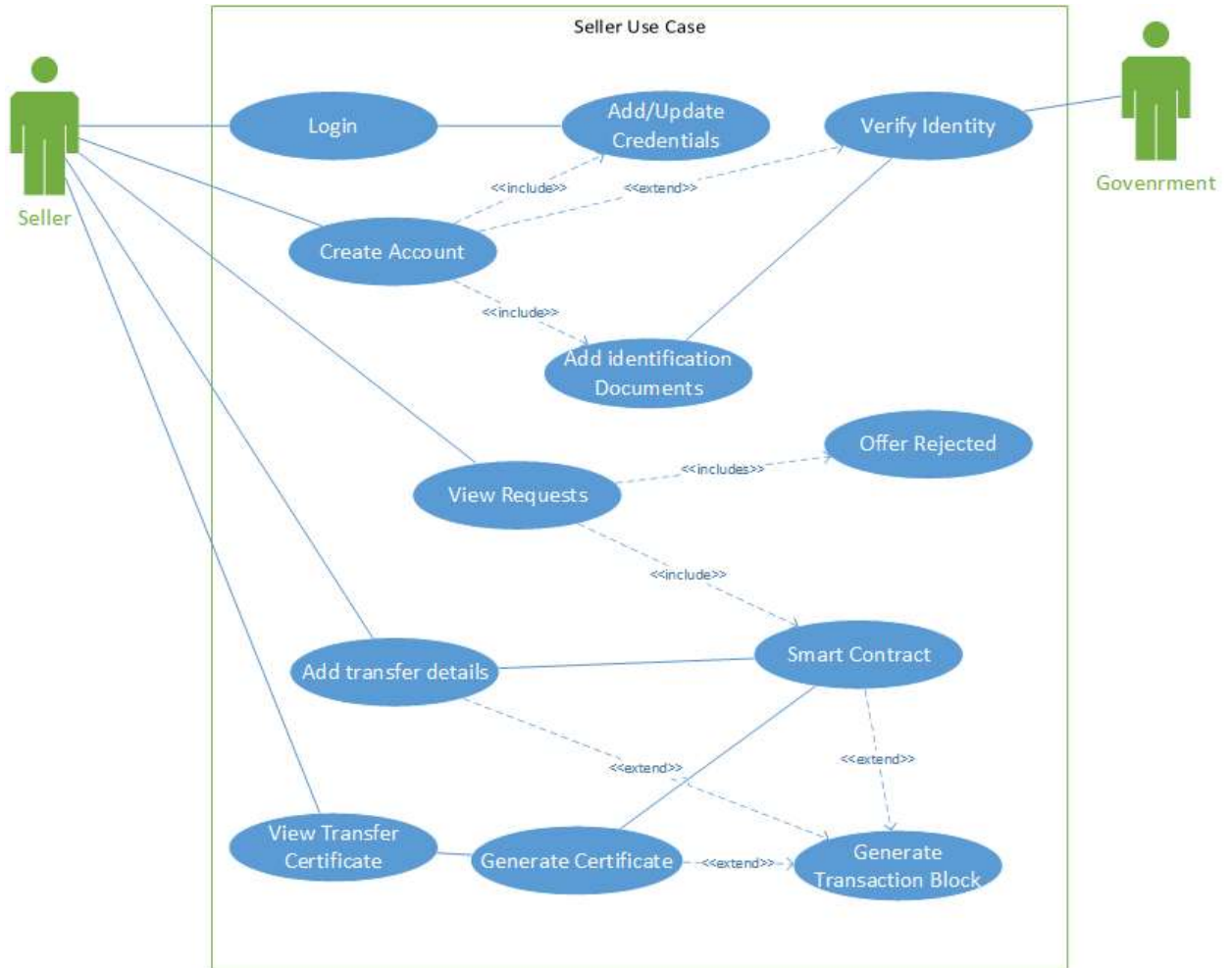


Figure 4.12: Use Case diagram

4.4.3.3 Buyer Use Case

The buyer is key to this process as they are the ones affected largely by Fraud in land transactions. They should be able to determine the authenticity and ownership of the land without the progression in third parties. The system enables them to be able to track the current land activities and the pending activities in which case the land should not be open for sale. They

should be able to purchase land with ease and get a complete report on the transaction and ensure security of their purchase.

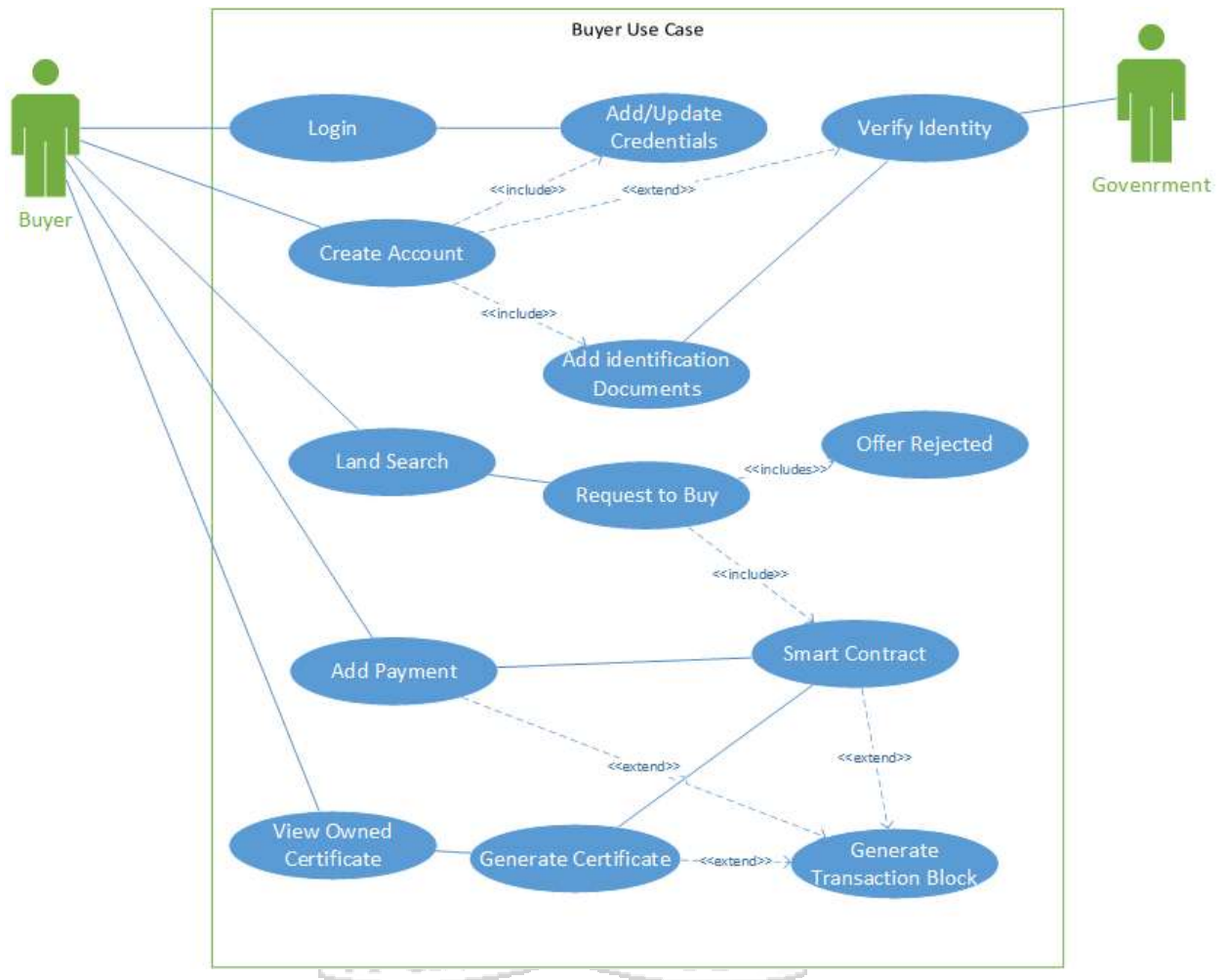


Figure 4.13: Use Case diagram

4.4.4 Use Case Narratives

The narratives explain the different event flows and how the system should work under given conditions. Different scenarios are created to define how the system meets the outlined user requirements and functional requirements.

4.4.4.1 Use Case Scenario 1

Primary Actor: User (Buyer/Seller)

Pre-Conditions: The government identity server is setup and running

Post-Conditions: The user has successfully created an account in the system. The buyer is able to log into the system

Events Flow

User Events	System Events
User has the national Identification documents at hand	
The user enters their details into the system: Full name, ID Number, KRA PIN, Passport Photo, Citizenship, Residence, Phone Number, Email	
	The system Requests Government Identity server for verification
	System Receives the verification details
System Prompts the user to create log in details	
	System Adds the log in details to allow access
	System Marks the user as verified
	System Stores users updated details in the system
User receives a confirmation email	
User confirms their email	
	System enables the user to log into the system
User receives a private identification Key	
User can log in	

Table 4.2: User Identity Scenario Narrative

4.4.5 System Sequence Diagram

The system shows the sequence of processes and flow of signals across the different actors and entities in the system. The system transaction details are initiated from the buyer. The buyer initiates the process from the land search, and then creates an offer letter, which the seller approves. After approval of the offer request, the sale agreement; smart contract is created which allows for the addition of payment details and the government levies to pay. Once the payments have been approved, the land administrator is requested to confirm the information flow and approve the transactions made. Figure 4.14 shows the sequence flow.

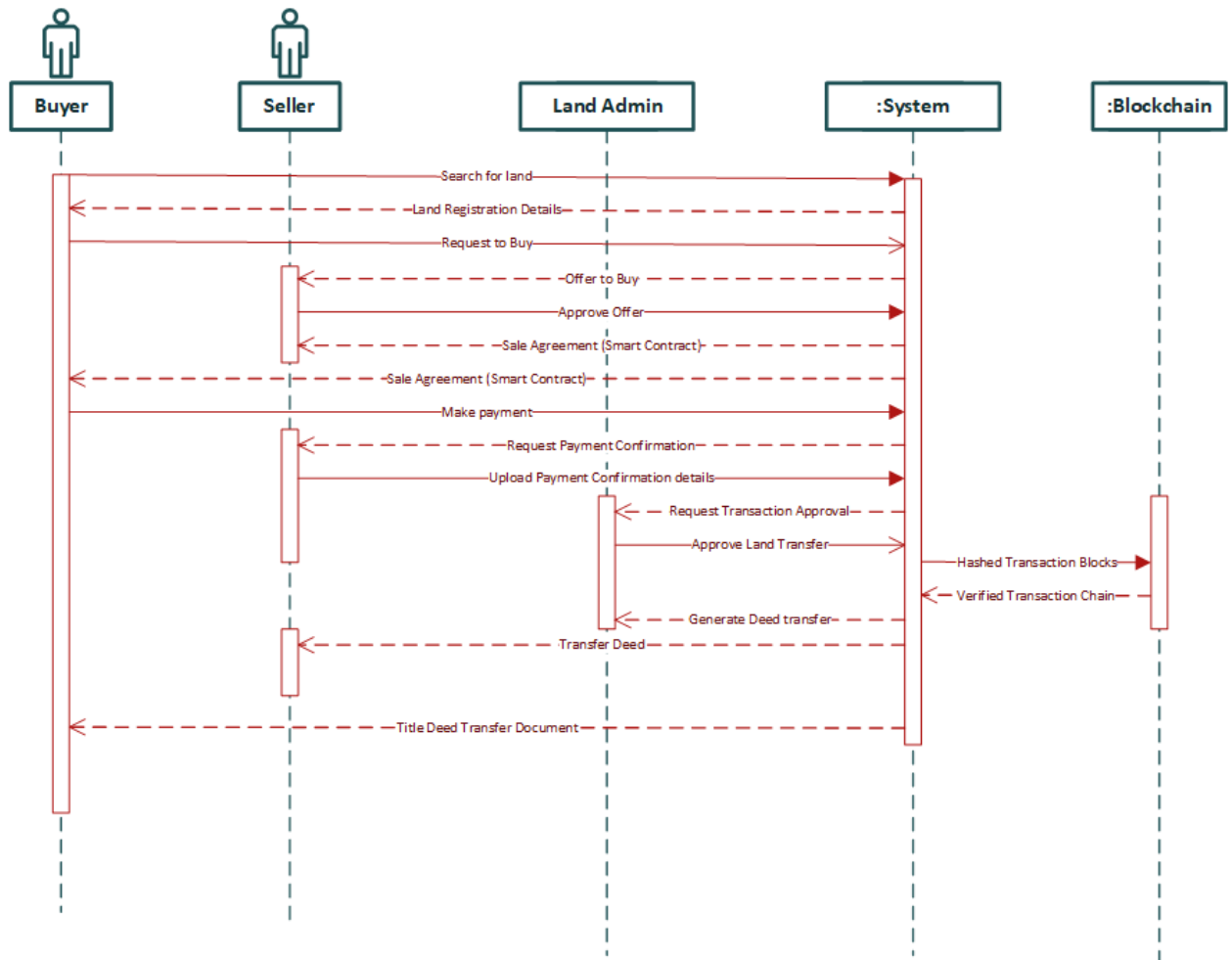


Figure.4.14: System Sequence diagram

The sequence diagram above shows how the different users interact to ensure the flow of information back and forth between the actors and the system. The land admin interacts with the system at minimal points, hence ensures independence of users' interaction and reduces the workload of the admin as efficiency of transfer processes is handled by the system.

4.5 System wireframes

The wireframes show how the system user interface and user experience is designed. It helps in ensuring the system is built in the right manner to support user activities. Below are the different wireframes on how the user is expected to interact with the system.

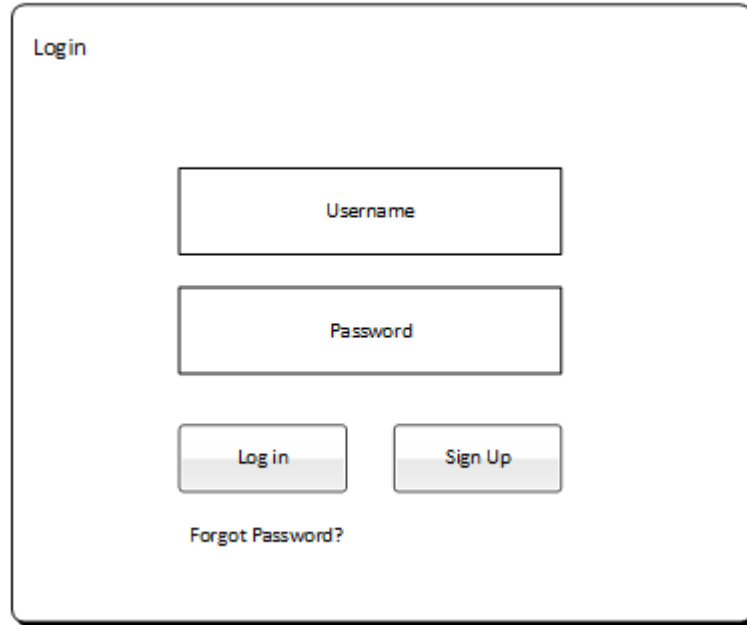


Figure 4.15: User Log in Screen wireframe

The user is expected to input their account credentials before using the system. The view is kept simple to ensure information clarity and task execution.

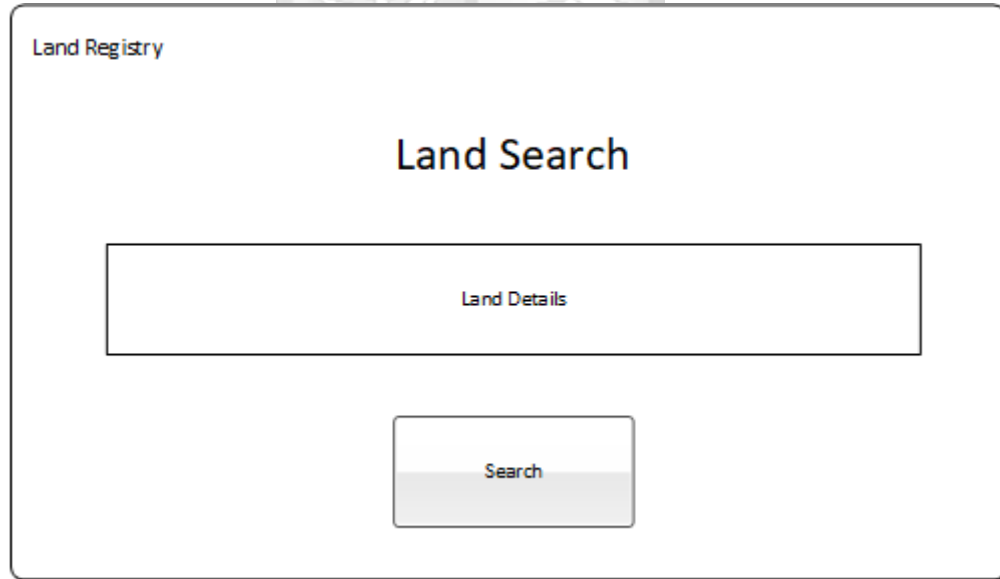


Figure 4.16: Search view wireframe

On successful login, the land search process is kept simple and intuitive to ensure clarity and reduction of cognitive burden for the user.

LR122		Search
Search Results		
Land Code: LR122/23	County: Muranga	View Details
Owned By: Regina Wairimu	Area Code: Nyumbani	Request to Purchase
Land Code: LR122/24	County: Muranga	View Details
Owned By: Regina Wairimu	Area Code: Nyumbani	Request to Purchase
Land Code: LR122/25	County: Muranga	View Details
Owned By: Regina Wairimu	Area Code: Nyumbani	Request to Purchase

Figure 4.17: Search details view wireframe

On Success, the user is shown the different land parcel that meets their search. From there, the user may choose to view more details on the land parcel or proceed with purchase of the land.

Detailed Land View

LR122/23

Owned By: Regina Wairimu

Previous Transfers	
TRANS201600105	Approved By: Arap Koilel (Land Commissioner)
Requested by: Muriuki	Payment reference: PD34590248023
Owner: kamau	Valuation: KES 1000,000.00 /=-
Date transferred: 2016/05/01	
TRANS201600105	Approved By: Arap Koilel (Land Commissioner)
Requested by: Muriuki	Payment reference: PD34590248023
Owner: kamau	Valuation: KES 1000,000.00 /=-
Date transferred: 2016/05/01	
TRANS201600105	Approved By: Arap Koilel (Land Commissioner)
Requested by: Muriuki	Payment reference: PD34590248023
Owner: kamau	Valuation: KES 1000,000.00 /=-
Date transferred: 2016/05/01	

Figure 4.18: Land detail view wireframe

The land detail view ensures, the user can view the previous transactions on the land parcel and if there is any broken chain, the system flags an error.

Chapter 5: Implementation and Testing

5.1 Introduction

The transactional tool will be used by different actors. Hence, the need to have a refined user experience and access control across the system. Since the system is security focused, security features have been implemented across the system to ensure separation of concerns and activities. This chapter focuses on the tools implemented and the defined user requirements.

5.2 Development tools

The proposed tool is developed using python programming language. Since the tool is a web based, we used the Django framework which offers high scalability and fast prototyping environment. We expect the system to handle multiple users and be able to store the user information on a persistent based system. Hence the use of the MySQL database for storing information. We are focusing on use of blockchain technology for verification and security, hence the inclusion of HyperLedger for transactions storage.

5.3 System Requirements

The system is expected to run on a web based environment. Hence, the computers must have the following to operate:

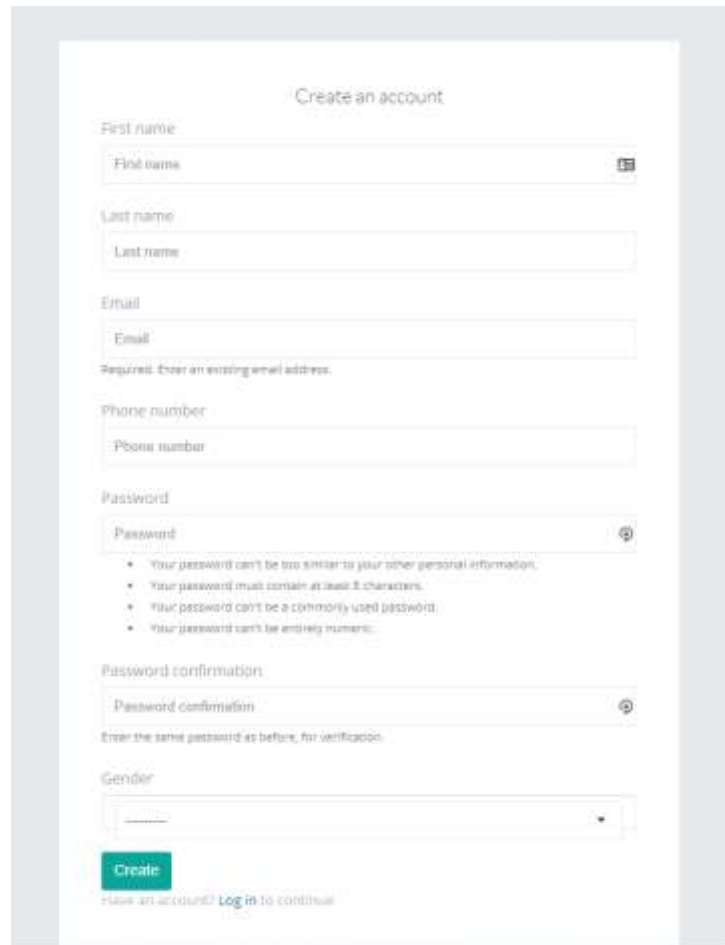
- i. A laptop with operating system; windows 7 or higher, Ubuntu 16.04 or higher and Mac OSX.
- ii. The computer processor should be above i3 2.4GHz, with a minimum RAM of 4B and minimum hard Disk Space of 10GB.
- iii. The Computer must be pre-installed with a web browser preferably Chrome or Firefox both of versions after 2018.

5.4 System Functionality

The system has various modules that depict a given user story for every user. The different modules operations are described in detail as follows, with each capturing the different user operations and information types.

5.4.1 Sign Up

The system implements an easy signup page with the fundamental information on the page. The user is allowed to update individual information on the system which will be verified by the administration officers working together with the relevant government agencies.



The image shows a web form titled "Create an account". It contains the following fields and elements:

- First name:** A text input field with a placeholder "First name" and a small icon on the right.
- Last name:** A text input field with a placeholder "Last name".
- Email:** A text input field with a placeholder "Email". Below it, a note says "Required: Enter an existing email address."
- Phone number:** A text input field with a placeholder "Phone number".
- Password:** A text input field with a placeholder "Password" and a small icon on the right. Below it, a list of password requirements:
 - Your password can't be too similar to your other personal information.
 - Your password must contain at least 8 characters.
 - Your password can't be a commonly used password.
 - Your password can't be entirely numeric.
- Password confirmation:** A text input field with a placeholder "Password confirmation" and a small icon on the right. Below it, a note says "Enter the same password as before, for verification."
- Gender:** A dropdown menu with a placeholder "Gender" and a small icon on the right.
- Create:** A green button with the text "Create".
- Log in to continue:** A link with the text "Have an account? Log in to continue".

Figure 5.1: Sign up form view

5.4.2 Login

The system login is implemented in an easy to use way. The page for login requires from the user, the username and the password. On successful login, the user is redirected to a simple interface for land search.

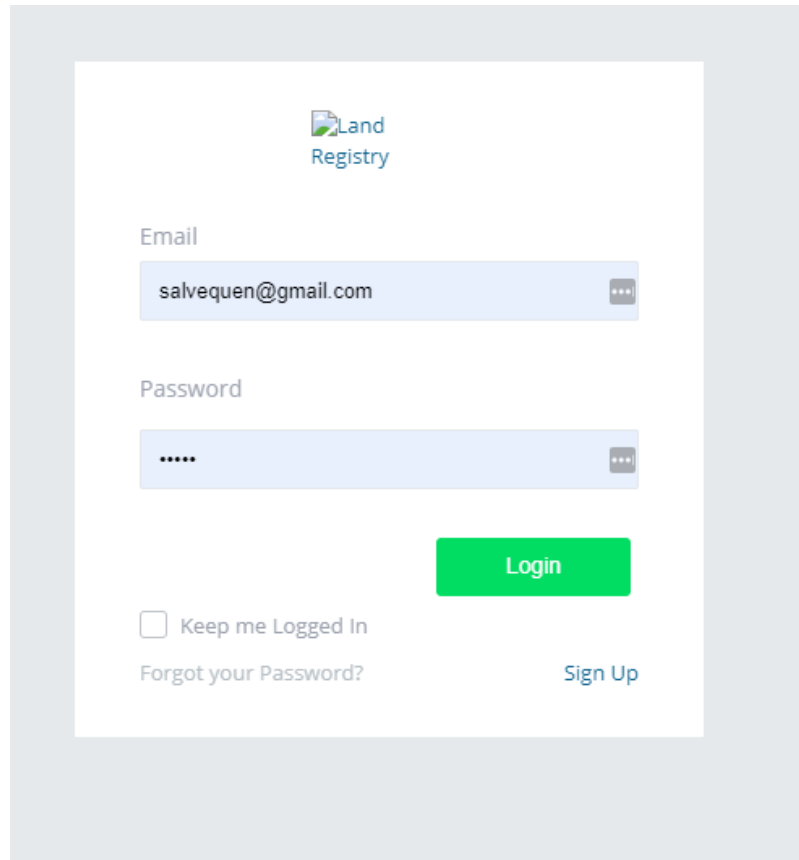


Figure 5.2: Login screen view

5.4.3 Search Page

The main page for the user; buyer and seller, is a simple search page. The user is able to input the search details for the land. The search page leads to a search result to allow the user view the different results according to the search. On the search page, the user may choose to view the land details. The user is also able to see a validity of the land details before progressing with purchase. Hence, allows for earlier decision making.

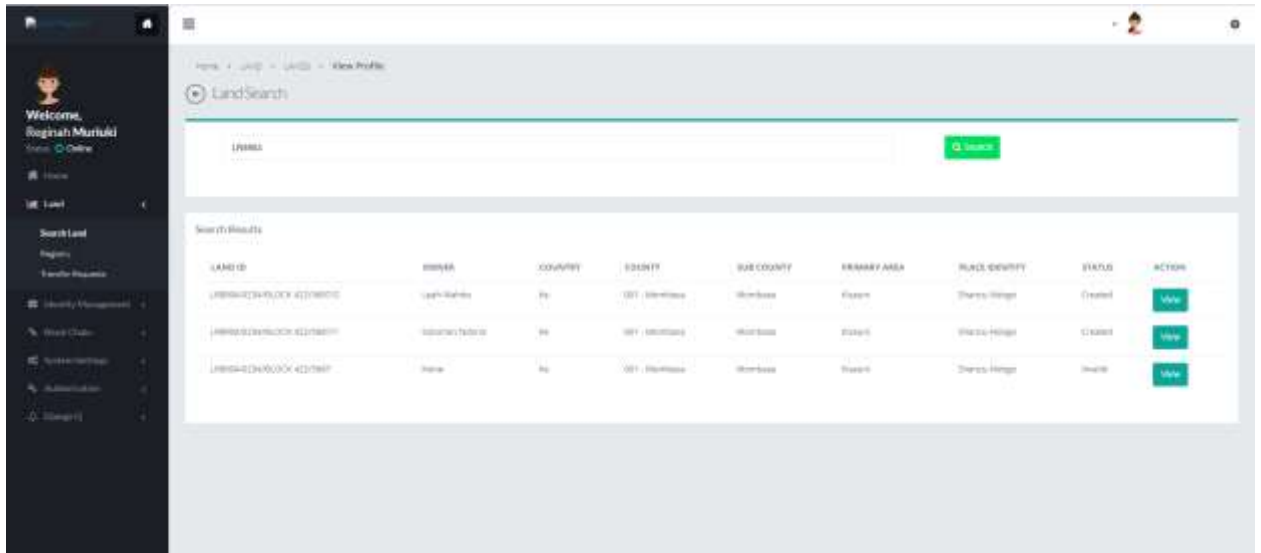


Figure 5.3: Land search view

5.4.4 Land Details

A valid land, shows the current location. The geo-data is set off due to map key payments, but can be included in future to allow for ease of visibility. A nullified title deed would have a nullification date that corresponds to the new deed owner transfer date. Every deed has a checksum that is used for verification. The land details page shows mainly the previous transactions, currently pending transactions, ownership, registration details, and the verifications on the land. From the information, the Land verification depends on the consensus from previous transactional blocks on the system.

Home > LAND > LANDS > View Profile

LR8904/0234/BLOCK 422/5697/2 (created) Land

Land Details	Larger Description	Finer Details	Details
Code: LR8904/0234/BLOCK 422/5697/2	Country: KE	Location: Shanzu	Area: 2.0 Acres
Current Owner: Leah Wahita	County: 001 - Mombasa	Sub Location: Shanzu-Ndoga	Perimeter: 0.0 Ft
Pending Requests: 0	Sub County: Mombasa	Primary Area: Kisauni	Latitude: 0.00014
Is Verified: Yes	Division: Kisauni	Place Identity: Shanzu-Ndoga	Longitude: 0.00017

Transfer Requests

Land has no transfer Requests.

Transfer Deeds

OWNER	LAND AREA	DATE CREATED	DATE APPROVED	DATE VERIFIED	IS NULLIFIED	CHECKSUM
Leah Wahita	2.0	May 27, 2019, 11:58 a.m.	May 27, 2019, 11:56 a.m.	May 27, 2019, 11:56 a.m.	No	eyJpZC...PBTjRRFzc - view
Solomon Ndoria	12.0	May 26, 2019, 7:47 p.m.	May 26, 2019, 7:47 p.m.	May 28, 2019, 7:47 p.m.	May 27, 2019, 11:06 a.m.	eyJpZC...IfArdyE3E - view

Transfer Transactions Chain

Figure 5.4: Land detail view

5.4.5 User Profile

Every user has a profile to view their property, current requests and the owned property. The information available is key to their information. On the page, the user is able to add their details and if they have been approved by the Identity management system. The user will also have a signature generated by the system to uniquely identify them across the system and their approvals.

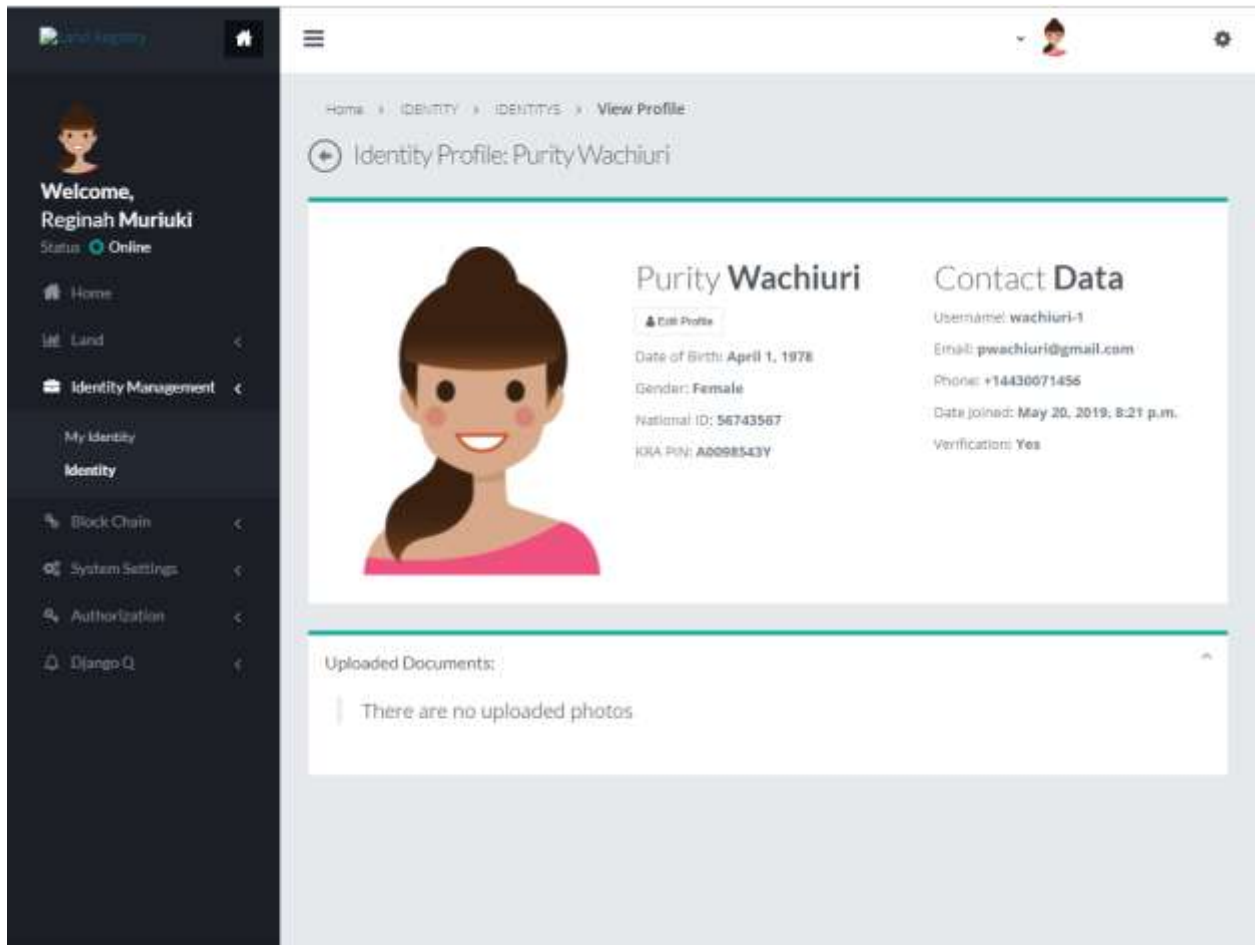


Figure 5.5: User Identity/Profile view

5.4.6 Block Chain Generation

The system generates the transactional blocks using the SHA256 encryption using the different user's signatures. The signatures are immutable and if corrupted, the user is issued a new one as the old one is archived. From these transactional blocks, the user is able to view the authenticity of their property and the transfer details.

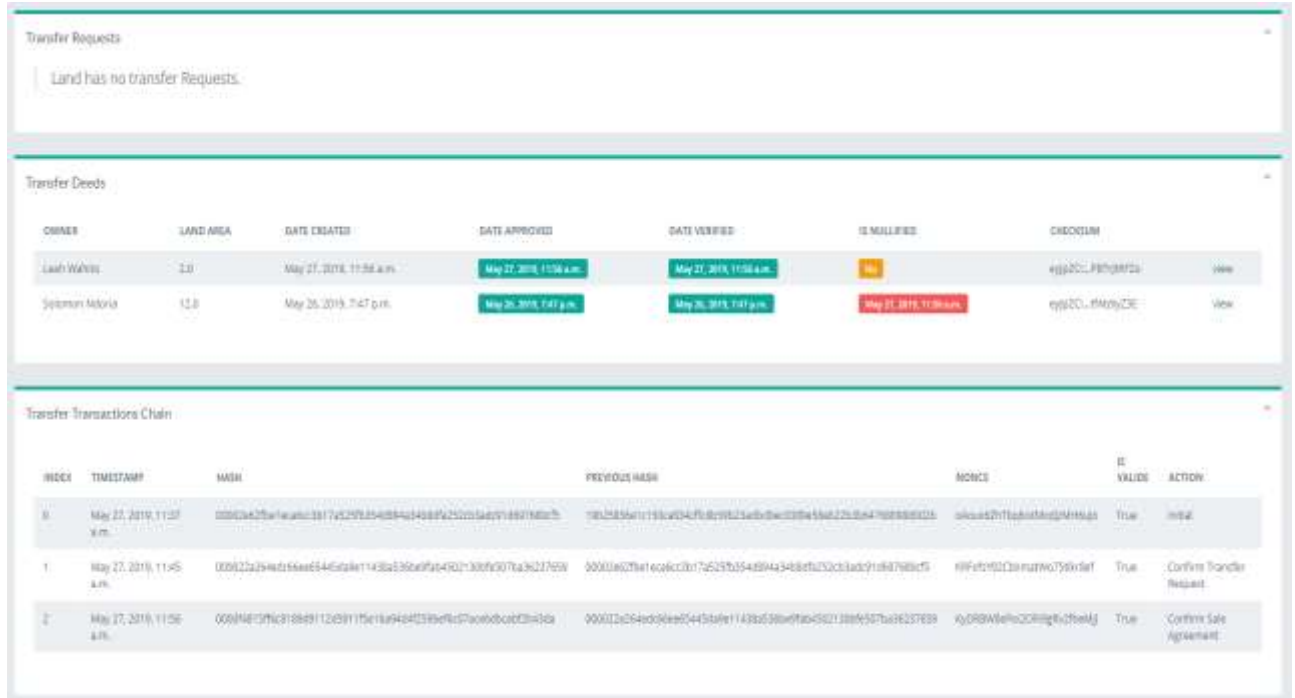


Figure 5.6: Land transactions chain view

5.5 System and Information Security

There are various ways control and fraud can be committed even within a system. Since the system involves interaction on precious commodity (Land), the internal controls are no exception to have better control of the system. The first level of security is to be implemented across the different users. We implement a role based object level and 2 factor authentication protocol.

Role Base Implementation involves separation of different users and functionality according to the different roles. Therefore, a user cannot do an action not prescribed for them.

User	Access Level	Permissions Assigned
Buyer	Normal.	Land Search Buy request Make Payment for Land Approve the transaction
Seller	Normal.	Approve Buy Request Add Payment Details

		Approve Land Demarcation/Split
Land Administrator	Admin	Approve Transactions Approve land Detail Changes
Land Registry Clerk	Medium	Add Land Registry Add levies Payments Update land Details
Tech Support	Developer	Update user token Reset user Credentials System maintenance

Table 5.1: User Access Level Matrix

The system uses username and password for users to log into the system. The username is unique across all. The system encrypts all the passwords using SHA256. The passwords requirements; more than 8 characters and includes special characters together with the alphanumeric.

5.6 System Testing

There are different types of tests to be carried out to ensure the accuracy of the system to perform in accordance to the set objectives and requirements. These tests include unit tests, integration tests, and User acceptance test.

5.6.1 Unit testing

At this level we perform a test on the individual key components of the system to ensure their operation independent of the other parts of the system. Table 5.2 shows the system components unit tests

Component	Test Case	Precondition	Test Steps	Test Data	Expected Result	Actual Result	Status
Search	Be able to return land Search	A registered user	1. Login 2. Open Land	Land unique Code;	Land Details, Location,	Land Size, owner, Current	Pass

	Details		Search 3. Enter Land Code	LR122/23	Size, Owner and Status	transactio n status, Location	
Hash	Be able to hash/encry pt a transaction	A complete sale agreement	1. Approve the sale transfer	Sale Agreemen t; SA201900 1	Generated block of transactio ns from offer to final payment	An immutable record on the transactio ns	Pass

Table 5.2: Sample Unit tests

5.6.2 Integration Tests

The integration tests verify the interaction of the different components and behavior if put together. We did an integration test, between the system and a separate identity verification system.

Test Case	Test Steps	Test data	Expected Result	Actual Result	Status
Identity Verification	1. Create a user Account 2. Upload KRA Pin Details	KRA PIN A0003247S	Account Verified	Account Verified	Pass
Identity Verification	1. Create a user Account 2. Upload KRA Pin Details	KRA PIN A000247S	Account Verification Failed	Account not Verified	Pass
Update HyperLedger	Generate Transaction Hash	Land Transfer LR122/23	Ledger updated chain	Ledger Updated	Pass

	Send to HyperLedger		LR122/23 successfully	successfully	
--	------------------------	--	--------------------------	--------------	--

Table 5.3: Sample Integration Test

5.6.3 User Acceptance Tests

The research is based on ensuring transaction tracking and testing immutability of the records. The User Acceptance tests ensure the functional requirements are met and the research objectives are achieved. Table 5.4 shows the executed acceptance.

Scenario	Test Case	Pre-Condition	Test Steps	Test data	Expected Result	Actual Result	Status
Visible Land Transactional Activities	User should be able to view the previous land transactions	Land transfer done through the system more than once	<ol style="list-style-type: none"> 1. Search for land 2. Open land details 	LR122/24	View of current land owner, Land immutable activities with detailed people signatures	The land transactions done, who did the transaction.	Pass
Immutable Land Records	User cannot change the land details without proper log	Land Exists in the system	<ol style="list-style-type: none"> 1. Edit the land Owner on database 2. Search for land through system 3. View land 	LR122/25	Land should be flagged off as changed. Owner should be notified and the land admin should be notified to revert	Land view marked red as invalid, Owner got a notification on system that land is edited A button	Pass

			activities and status		changes as in HyperLedg er	to revert to ledger is required	
--	--	--	-----------------------------	--	-------------------------------------	---------------------------------------	--

Table 5.4: User Acceptance Test



Chapter 6: Discussions

6.1 Introduction

The research was based in analyzing the current structure of land transactional activities and on how best to implement a solution to aid in ensuring security and transparency of the land activities. The tool aims to ensure the transactions are recorded, verified and transparent across all the parties involved. The integrity of the transactions are maintained through blockchain across multiple peers and with hash of data or checksums to ensure ease of verification and maintenance of validity.

6.2 Research and Tool Review

The essence of a government having a land tracking tool is because the administration, management and transfer of land between entities as functions that are in close association with most social and economic factors that is mismanaged would lead to a direct negative impact on the country's economy, agriculture and social welfare of the citizens (Kalantari, et al., 2015).

Through establishing secure and reliable land based transactions and information, the ultimate goal is to offer a streamlined security of land tenure for both the government and the public. To achieve the security and immutable nature, the proposed system runs on the blockchain technology. As indicated earlier on in the literature review, the blockchain achieves immutability by time-stamping each series of records that are immutable and is not managed by one computer, rather by a cluster of computers within the chain. The management by the cluster of computers ensures that the information is randomized and secure and the data cannot be lost since it does not have one physical location. The tool would then table transparent and secure results that can be helpful and transparent to land owners and other stakeholders concerned with the status of the lands within the country (Kalantari, et al., 2015). Consequently, the tool would have the potential to cut down of bureaucracies to reduce the transaction time, cost, and required procedures that would then help in facilitating other related services such as issuance of permits, access to loans, and acquisition of infrastructure services.

By basing the land transaction tracking from the information point of view, various objectives related with the management of land are able to be achieved. For instance, the tool would able to open better opportunities for the growth and development of the needed links between conventional land processing frameworks and the economic development of the said

lands (Kalantari, et al., 2015). The tool to track land transactions can be beneficial to many users by responding and providing them with the basis of coming up with informed decisions pertaining buying and selling of land. Additionally, focus on the information retrieval and management would aid the system managers to create relevant strategies to reform the process of land transactions and registration. Previous research has had a relatively high emphasis on the narrow role of land transactions in property taxation, and conveyance (Manji, 2015). Most of the conventional forms of land acquisition only concentrate on the administrative and legal arrangements based on set jurisdictions or the type of registration or transference system being used (Kalantari, et al., 2015). There have been other concerns that are in relation to the land transaction issue such as the economic and the cadastral perspective. The cadastral perspective not only has it been able to recognize and implement the information aspect and the role it plays in land transactions, but it has also been represented as a mode of changing the conventional land tenure to more efficient registered titles to come up with a more, better and comprehensive tool to track land transaction activities.

6.3 Limitations and Assumptions of the Developed Tool

The developed tool aims to create a transparent and an easy to use system for the buyers, sellers and Land administration team. There are still some limitations towards the system that would reduce its efficiency and integrations to curb the challenges and fraudulent activities in the land activities. The limitations include: -

- i. Identity verification. One of the fundamental elements of the system is highly dependent on the government agencies for user verification. In case the data issued from the government is incorrect and a wrong person is verified into the system, there would be a loophole for fraudulent activities.
- ii. The system is also largely dependent on the maps to show clear location of land. Currently the purchase of google map keys is expensive and is limited in this tool. And in future it would be costly to update the maps and how they are structured in the country considering, not all the lands are updated in the google maps.

- iii. Since the tool is online, there is limitation in internet access across the whole country which would allow access by the different parties in different remote areas. This may cause slow penetration of the tool and its wide usage.

The Assumptions are: -

- i. The system administrator acts as the Identity Management Authority (IMA) who for the purpose of this system is an officer in the ministry of lands
- ii. The system administrator also acts as the immigration officer, and the KRA official to verify and approve different identities.
- iii. The tool assumes that all the negotiations e.g. bidding or highest sale offer about land have been done prior and focuses on the transactional processes only

6.4 Benefits of the Developed Tool

The developed tool presents the following benefits: -

- i) It promotes transparency as the data are embedded within the network as a whole, meaning they are for public consumption. This will increase security and avoid corruption by distributing the maintenance of records to all parties involved, rather than to a few.
- ii) The blockchain cannot be controlled by any single entity and has no single point of failure because the blocks of information are identical across its network. Its structure makes it suitable for supply chain management, identity and database management. The latter function will also help to streamline the land title registration process.
- iii) Since the database is distributed across a network of computers, the records will be protected by codes (cryptography), which will be free from human error, editing or removal.
- iv) The use of smart contracts, which are programmable contracts that self-execute when certain conditions are met, would speed up the registration process making land registries more efficient and cost effective.
- v) The technology can document clear ownership and transfer footprints, weeding out cases of fraud. The process will help link an individual's land/ property with their details. Each property would be uniquely coded and linked to a smart key which would be held only by the owner.

- vi) The blockchain database has a massive storage capacity therefore it will be able to hold as much data as is transmitted on a daily basis, without crashing. This would promote effective property management as information can be reviewed in real time.
- vii) The technology further aids in the devolution of public services and gives investors quicker access to property, allowing Kenya to compete globally due to its enhanced business efficiency.
- viii) It separates the process of land transactions from the monetary procedure therein, reducing, if not eradicating, corruption.



Chapter 7: Conclusions and Recommendations

7.1 Conclusions

The research emphasized on coming up with a system that can be used to track land transaction activities. It was aimed at keeping records of each transaction activity that occurs before the final acquisition process of the land parcel. In the course of the research, different techniques used in the projects selection were discussed as indicated in the Literature review section. The researcher was able to compare and contrast the issues resented in the old system and to what was being proposed. Additionally, the researcher was able to come up with the existing gap that made it essential to have a secure transparent system that is immutable in nature.

The project uses a questionnaire as the primary form of data collection and the researcher analyses the results as seen in chapter three, basing on a deliverable of 100 respondents. The researcher is then able to make inference and draw tentative data that would aid in the development of the system. A requirements analysis is conducted to ascertain the needs of the system and how it ought to work both in a functional and non-functional manner.

With the new system, the land transaction activities will not only be made transparent, but will also be easy to retrieve and significantly reduce the time taken to complete a complete registration process. The buyers and landowners can easily check for the land ownership status and view through the historical data or if the land has any form of restriction in the national or country government. The system will also prevent duplicating and alteration of stored data as they will be made immutable and enforced with the blockchain technology. The blockchain technology is beneficial as it does not have a centralized location that will lead to loss of data and make it impossible for changing stored data as it is replicated in a chain of computers all over the network.

7.2 Recommendations for Further Research

In order to have an even more robust and seamless system model in action, the researcher recommends additional study to be conducted on the following areas of concern

- i. Inclusion of system integration so that once a transaction occurs; the data is added automatically instead of sending to the land registry office to perform the updates.

- ii. Addition of feedback mechanism to alert or inform the clients on the progress of the transactions through SMS or email.
- iii. Facilitate remote interactivity so that people do not have to travel in order to request of commencement of the service.
- iv. Inclusion of face identification, to allow for in person verification and transfers. This would increase tightening of security.



References

- Amrit S, & W. Muigai (2018), *Digitalization of the Land Registries in Kenya*.
- Baskarada, S. (2014). Qualitative case study guidelines. Baškarada, S.(2014). Qualitative case studies guidelines. *The Qualitative Report*, 19(40), 1-25.
- Bonett, D. G., & Wright, T. A. (2015). Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning. *Journal of Organizational Behavior*, 36(1), 3-15.
- Chambers, J. M. (2017). *Graphical Methods for Data Analysis: 0*. Chapman and Hall/CRC.
- Coindesk. (2017) A (Short) Guide to Blockchain Consensus Protocols.
- Cope, D. G. (2014, January). Methods and meanings: credibility and trustworthiness of qualitative research. In *Oncology nursing forum* (Vol. 41, No. 1).
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Dawidowicz, A., & Zróbek, R. (2014). Analysis of concepts of cadastral system technological development. In *Environmental Engineering. Proceedings of the International Conference on Environmental Engineering. ICEE* (Vol. 9, p. 1). Vilnius Gediminas Technical University, Department of Construction Economics & Property.
- Dekker, H. A. (2017). *The invisible line: Land reform, land tenure security and land registration*. Routledge.
- Doshi, M., Kago, C. W., Kamunde-Aquino, N., Kiguatha, L., Idun, Y. N. A., & Chapman, S. (2014). Land Tenure classifications in Kenya. *REDD+ Law Project. Baker & McKenzie and the Cambridge Centre for Climate Change Mitigation Research, Cambridge*, 2075- 2092.
- Eck, K. (2014). The law of the land: Communal conflict and legal authority. *Journal of Peace Research*, 51(4), 441-454.
- Elliott, H. (2016). Planning, property and plots at the gateway to Kenya's 'new frontier'. *Journal of Eastern African Studies*, 10(3), 511-529.

- Enemark, S., Bell, K. C., Lemmen, C. H. J., & McLaren, R. (2014). *Fit-for-purpose land administration*. International Federation of Surveyors (FIG).
- Fazan, S. H. (2014). *Colonial Kenya observed: British rule, Mau Mau and the wind of change*. Bloomsbury Publishing.
- Goldman Sachs Group, (2016). *Profiles in Innovation: Blockchain- Putting Theory Into Practice*.
- Government Office for Science. (2015) *Distributed Ledger Technology: beyond block chain*.
- Handcock, M. S., Gile, K. J., & Mar, C. M. (2014). Estimating hidden population size using respondent-driven sampling data. *Electronic journal of statistics*, 8(1), 1491.
- Holden, S. T., & Otsuka, K. (2014). The roles of land tenure reforms and land markets in the context of population growth and land use intensification in Africa. *Food Policy*, 48, 88-97.
- IBM. (2016) *Leading the pack in blockchain banking: Trailblazers set the pace*.
- Jagtap, S. (2015). Aesthetic design process: Descriptive design research and ways forward. In *ICoRD'15–Research into Design across Boundaries Volume 1* (pp. 375-385). Springer, N
- Kalantari, M., Dinsmore, K., Urban-Karr, J., & Rajabifard, A. (2015). A roadmap to adopt the Land Administration Domain Model in cadastral information systems. *Land use policy*, 49, 552- 564.
- Keith Weed & Babs Rangaiah, (2018) *How Blockchain is Bringing Trust to Digital Ad Buys*, IBM, <https://www.ibm.com/blogs/think/2018/02/45885>
- Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners*. Sage Publications Limited.
- Lane, C. (2014). *Custodians of the Commons: Pastoral Land Tenure in Africa*. Routledge.
- Lang, K. (2019). *Land registration and blockchain*. *Taylorwessing.com*. Retrieved 22 April 2019, from <https://www.taylorwessing.com/download/article-land-registration-blockchain.html>

- Lemmen, C., Van Oosterom, P., & Bennett, R. (2015). The land administration domain model. *Land use policy*, 49, 535-545.
- Manji, A. (2015). Whose land is it anyway? The failure of land law reform in Kenya. *Africa Research Institute Counterpoint*, 1-13.
- Roller, M. R., & Lavrakas, P. J. (2015). Applied qualitative research design: A total quality framework approach. Guilford Publications.
- Schabenberger, O., & Gotway, C. A. (2017). *Statistical methods for spatial data analysis*. Chapman and Hall/CRC.
- Swan, M. (2015). *Blockchain: Blueprint for a new economy*. O'Reilly Media, Inc..
- The Government Lands Act. (1984). *Chapter 280*, Laws of Kenya.
- The Land Adjudication Act. (1977). *Chapter 284*, Laws of Kenya.
- The Land Consolidation Act. (1977). *Chapter 283*, Laws of Kenya.
- The Land Titles Act, (1908). *Chapter 282*, Laws of Kenya.
- The Law of Succession Act, (1981). *Chapter 160*, Laws of Kenya
- The Registered Land Act. (1989). *Chapter 300*, Laws of Kenya.
- The Standard eNewspaper. (23 December 2018). *Newsstand.standardmedia.co.ke*. Retrieved 31 May 2019, from <https://newsstand.standardmedia.co.ke/StandardGroupLimited/TheStandard/TheStandard/preview/100/23122018100524698>
- The Swynnerton R. J. M. (1954). *A Plan to Intensify the Development of African Agriculture in Kenya*.
- VanOosterom, P., & Lemmen, C. (2015). The land administration domain model (LADM): motivation, standardization, application and further development. *Land use policy*, 49, 527-534.

Appendices

Appendix i: Research Questionnaire

This questionnaire is designed to collect data on the land transaction activities from land owners and registry employees in Kenya. Kindly answer these questions. The information collected will be treated with the highest degree of confidentiality.

Section A: General Information

1. Responding as a: (Kindly tick as appropriate)

Land Registry ()

Landowner ()

2. If in land registry please indicate category: (Kindly tick as appropriate)

Junior Employee ()

Mid-level employee ()

Senior-level employee ()

3. Are you familiar with the current system

Yes ()

No ()

Not sure ()

Other (specify) _____

4. Are you a Kenyan Citizen?

Yes ()

No ()

Other (specify) _____

Section B: Impact of Current System

5. Have you ever been involved in Land transfer process using the current system?

Yes ()

No ()

6. Do you consider the current system as an efficient in service delivery?

Yes () No () Not sure ()

7. Does the current system ensure security of data?

Yes () No () Not sure ()

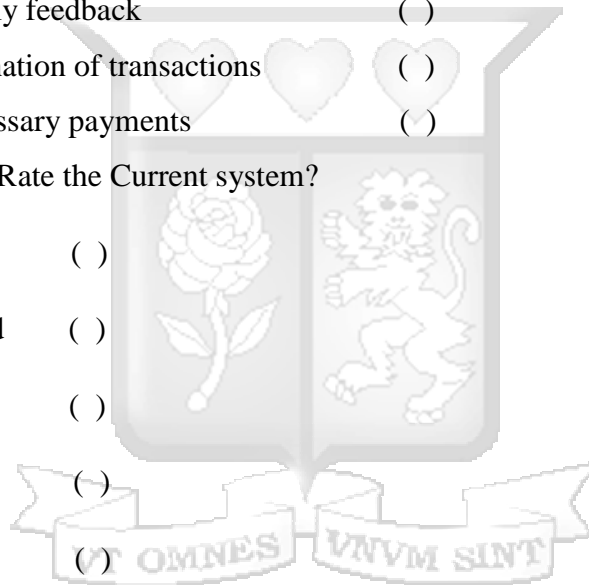
Other (Specify) _____

8. What according to you is the main challenge affecting the current system?

- a) Undocumented Transactions ()
- b) Data Mutability ()
- c) Untimely feedback ()
- d) Coordination of transactions ()
- e) Unnecessary payments ()

9. How would you Rate the Current system?

- Excellent ()
- Very Good ()
- Good ()
- Fair ()
- Poor ()



10. Is there need for a new system?

Yes () No ()

If your answer is yes, please indicate the reasons why in the box below?

Appendix ii: Use Case Narrative

The narratives explain the different event flows and how the system should work under given conditions. Different scenarios are created to define how the system meets the outlined user requirements and functional requirements.

Use Case Scenario 2

Primary Actor: Buyer

Pre-Conditions: The land details exist in the system and the registry is cleaned up. Buyer is able to log into the system. Buyer has a transaction Private Key.

Post-Conditions: The buyer should be able to purchase a land and receive transfer certificate

Events Flow

User	System
Buyer Enters log in credentials	
	System Authenticates the details
Buyer views list of their land	
Buyer Enters details of land to purchase	
	System returns the land details if they exist
Buyer selects to view transactions	
	System details the land previous transactions, Current owner and status (Approved, pending transfer, invalid)
Confirm to proceed on offer to buy. Enter details of land piece to purchase and valuation	
	Generate an offer letter to buy and notify Seller and Land Admin
Check Seller Approval Use case	
Receive notification on current land valuation	

Approve amount to pay on valuation	
	Notify the seller on confirmed details
	Generate a sale agreement
Add payment details	
	Request payment details confirmation from Seller
Add payment of government Levies	
	Confirms matching payment across different users
	Split the land if necessary to transaction detail
	Generate a transaction document
	Timestamp the transaction details
	Generate block of previous transactions
	Generate Deed certificate
	Send transaction block to Hyper Ledger
Receive a digitized copy of Land	

Table 4.3: Buyer Land transaction Scenario

Use case Scenario 3

Primary Actor: Seller

Pre-Conditions: The land Details are updated on the system. There is a set offer to buy from User.

Post-Conditions: Land transferred to another user.

Events Flow:

User	System
Log into the system	
	Issue Access through verification
Receive Offer to buy notification	
Approve Offer to buy by adding user Key (signature)	
Add required payments details	

	Generate a sale agreement
Receive notification on buyer payment	
	System requests for their payment details
Add received payment details	
	Match payment from buyer.
	Generate a transaction document
	Split or add transfer details
	Generate transaction bloc
	Send transaction block to the Hyper Ledger
Receive certificate of transfer	

Table 4.4: Seller Land Transaction Scenario

Appendix iii: Sample Code Segment

The sample code segment shows different code snippets that define a given behavior on the tool. The code segment requires python knowledge to understand the code syntax.

Section A: System Abstract Base Model

The Abstract Base Model defines the system wide requirements for all model implementations. They define the key behaviour of the data type in the system

```
class BaseModel(models.Model):
```

```
    """BaseModel.
```

```
    The abstract base class offers the record level fields that are required
    for all models for audit purposes.
```

```
    It also has the functions to update the various model status
```

```
Usage:
```

```
    Create a django models class and instead of inheriting the models.
```

```
    inherit BaseModel.
```

```
    It will allow all the audit fields to be auto created and autopopulated
```

when required data is updated.

Extends:

```
models.Model
```

Variables:

```
status {CharField}

date_created {DateTimeField}

date_modified {DateTimeField}

created_by {CreatingUserField}

modified_by {LastUserField}
```

"""

```
EXCLUDE_FIELDS = ['date_verified', 'verified_by', 'signature']
```

```
status = models.CharField(
    max_length=16, choices=ENTITY_STATUS, default='created',
    editable=False)

date_created = models.DateTimeField(auto_now=False, auto_now_add=True)

date_modified = models.DateTimeField(auto_now=True)

created_by = CreatingUserField(
    related_name="created_by_%(app_label)s_%(class)s",
    on_delete=models.PROTECT)

modified_by = LastUserField(
    related_name='modified_by_%(app_label)s_%(class)s',
    on_delete=models.PROTECT)

date_verified = models.DateTimeField(null=True, blank=True, editable=False)
```

```

verified_by = models.ForeignKey(
    'authentication.User', null=True, blank=True, on_delete=models.PROTECT,
    related_name='verified_by_%(app_label)s_%(class)s', editable=False)
signature = models.TextField(blank=True, null=True, editable=False,)

```

```

class Meta:

```

```

    """Class Meta data."""

```

```

    abstract = True

```

```

def c_dict(self):

```

```

    """Return model variables"""

```

```

    opts = self._meta

```

```

    data = {}

```

```

    for f in opts.concrete_fields + opts.many_to_many:

```

```

        if isinstance(f, ManyToManyField):

```

```

            if not self.pk:

```

```

                data[f.name] = []

```

```

            elif isinstance(f.value_from_object(self), list):

```

```

                data[f.name] = f.value_from_object(self)

```

```

            else:

```

```

                data[f.name] = list(

```

```

                    f.value_from_object(self).values_list(

```

```

                        'pk', flat=True))

```

```

        else:

```

```

            if isinstance(f.value_from_object(self),

```

```

                (datetime.date, datetime.datetime)):

```

```

        data[f.name] = f.value_from_object(self).isoformat()

# Check Decimal Conversion
elif isinstance(f.value_from_object(self), Decimal):
    data[f.name] = float(f.value_from_object(self))
elif isinstance(f.value_from_object(self), Money):
    data[f.name] = float(f.value_from_object(self).amount)
else:
    data[f.name] = f.value_from_object(self)

return data

def s_data(self):
    data = self.c_dict()
    for field in self.EXCLUDE_FIELDS:
        try:
            data.pop(field)
        except KeyError:
            pass

    return data

@property
def is_verified(self):
    """Check if the user is verified"""
    return bool(self.verified_by and self.date_verified)

def verification_display(self):

```



```

status = "Pending"

if self.is_verified:
    status = "Yes"

return status

def sign_data(self, user):
    """Sign the users details."""
    with reversion.create_revision():
        if self.is_verified and self.signature:
            raise ValidationError(
                "{} Already Verified by {}".format(self, self.verified_by))
        data = self.s_data()
        time_stamped = timezone.now()
        data.update({
            'verified_by': user.id,
            'date_verified': time_stamped.isoformat(),
        })
        signature = signing.dumps(data)

        self.verified_by = user

        self.date_verified = time_stamped

        self.signature = signature

        self.save()

        reversion.set_user(user)

        reversion.set_comment("Verified {} by {} on {}".format(
            self, user, time_stamped))

def verified_data(self):

```

```

        """Return the data signed."""

        return signing.loads(self.signature)

def verify(self):

    """Check if land is verified"""

    if not self.is_verified:

        raise ValidationError(

            "Error! {} {} MUST be Verified.".format(

                self._meta.model_name, self))

    return True

def signature_preview(self):

    """Return Mini signature."""

    if self.signature:

        return "{}...{}".format(self.signature[:7], self.signature[-10:])

```

Section B: Block Model

The Block model is an implementation of the blocks in blockchain. Each with a defined hash from the system and timestamp of data interlinked together through the chain.

```

classBlock(models.Model):
    time_stamp=models.DateTimeField(auto_now_add=False)
    index=models.IntegerField(auto_created=True,blank=True)
    data=models.TextField(blank=True,max_length=255)
    hash=models.CharField(max_length=255,blank=True)
    previous_hash=models.CharField(max_length=255)
    chain=models.ForeignKey(to='Chain',on_delete=models.CASCADE)
    nonce=models.CharField(max_length=255,default=0,blank=True)
    action=models.CharField(max_length=255,null=True,blank=True)

def__str__(self):
    return"Block "+str(self.index)+" on "+self.chain.name

```

```
def __repr__(self):
    return '{}: {}'.format(self.index, str(self.hash)[:6])
```

```
def __hash__(self):
    return sha256(
        u'{}{}{}{}{}'.format(
            self.index,
            self.data,
            self.previous_hash,
            self.nonce).encode('utf-8')).hexdigest()
```

```
@staticmethod
```

```
def generate_next(latest_block, data, action=""):
```

```
    block = Block(
```

```
        data=data,
```

```
        index=latest_block.index+1,
```

```
        time_stamp=datetime.datetime.now(tz=pytz.utc),
```

```
        previous_hash=latest_block.hash,
```

```
        nonce=SymmetricEncryption.generate_salt(26),
```

```
        action=action,
```

```
    )
```

```
    while not block.valid_hash():
```

```
        block.nonce = SymmetricEncryption.generate_salt(26)
```

```
        block.hash = block.__hash__()
```

```
    # block.save()
```

```
    # todo: remove
```

```
    return block
```

```
def is_valid_block(self, previous_block):
```

```
    if self.index != previous_block.index + 1:
```

```
        log.warning('%s: Invalid index: %s and %s'%
```

```
            (self.index, self.index, previous_block.index))
```

```
    return False
```

```
    if self.previous_hash != previous_block.hash:
```

```
        log.warning('%s: Invalid previous hash: %s and %s'%
```

```
            (self.index, self.hash, previous_block.hash))
```

```
    return False
```



```

ifself.__hash__()!=self.hashandself.index>1:
log.warning('%s: Invalid hash of content: %s and %s'%
(self.index,self.hash,self.__hash__()))
returnFalse
ifnotself.valid_hash()andself.index>1:
log.warning('%s: Invalid hash value: %s'%(self.index,self.hash))
returnFalse
returnTrue

defvalid_hash(self):
"""simulate Proof of work"""
returnself.__hash__()[ :4]=='0000'

```

Section C: Chain Model

The Chain model is a representation of a chain of blocks. It includes the function definitions to manage a chain of blocks and ensure validity of each block within the chain.

```

classChain(models.Model):
"""
    allows for multiple blockchain entities to exist simultaneously
"""
time_stamp=models.DateTimeField(auto_now_add=True)
name=models.CharField(max_length=255)

def__str__(self):
returnself.name

def__len__(self):
returnself.block_set.count()

def__repr__(self):
return'{}: {}'.format(self.name,self.last_block)

@property
deflast_block(self):
returnself.block_set.order_by('index').last()

defcreate_seed(self):

```

```

assertself.pkisnotNone
seed=Block.generate_next(
Block(hash=sha256('seed'.encode('utf-8')).hexdigest(),
index=-1),
data='Seed data',
action="Initial",
)
seed.chain=self
seed.save()

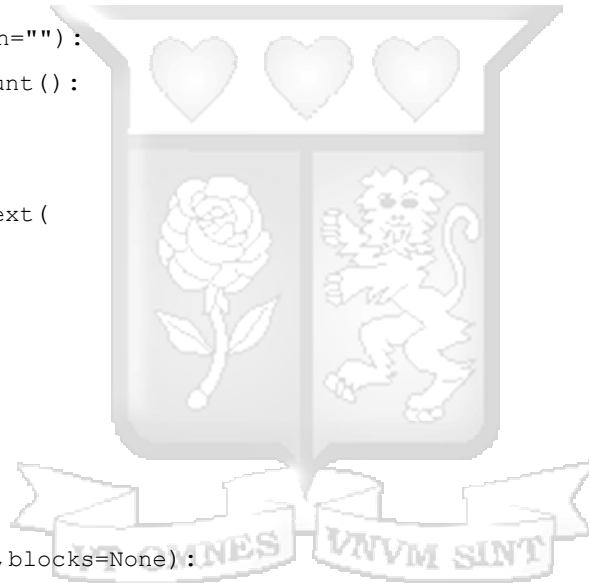
defis_valid_next_block(self,block):
returnblock.is_valid_block(self.last_block)

defadd(self,data,action=""):
ifnotself.block_set.count():
self.create_seed()

block=Block.generate_next(
self.last_block,
data,
action=action
)
block.chain=self
returnblock

defis_valid_chain(self,blocks=None):
blocks=blocksorlist(self.block_set.order_by('index'))
ifnotlen(blocks):
log.warning('Empty chain')
returnFalse
iflen(blocks)==1andblocks[0].index!=0:
log.warning('Missing seed block in chain.')
returnFalse
ifnotall(pblock.index+1==block.index==required_index
forpblock,block,required_indexinzip(blocks[:-1],blocks[1:],range(1,len(blocks)))):
log.warning('Chain is not sequential')
returnFalse
returnall(block.is_valid_block(pblock)
forpblock,blockinzip(blocks[:-1],blocks[1:]))

```



```

defreplace_chain(self,new_chain):
ifself.is_valid_chain(new_chain)andlen(new_chain)>len(self):
self.block_set.all().delete()
forblockinnew_chain:
block.chain=self
block.save()

defblocks_list(self):
returnself.block_set.order_by('index').all()

```

Section D: Land Model

The land model is a representation of the land entity and how it operates with the other system entities to ensure the correct land details are captured and verified within the system.

```

classLand(BaseModel):
"""Land

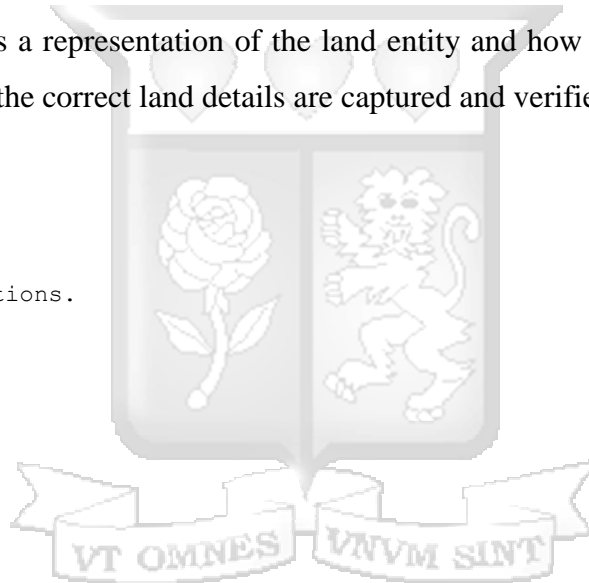
The Land specifications.

Extends:
    BaseModel

Variables:
    code {str}
    city {str}
    country {CountryField}
    county {County} -- [description]
    place_identity {str}
    latitude {DecimalField}
    longitude {DecimalField}
    primary_area {str}
    secondary_area {str}
    parent {Land}
    """

code=models.CharField(unique=True,db_index=True,max_length=128)
country=models.CharField(
max_length=15,choices=COUNTRY_LIST,default="KE")

```



```

county=models.ForeignKey(County,on_delete=models.PROTECT)
sub_county=models.CharField(
max_length=192,
help_text=_("Administrative Sub County of land"),null=True
)
division=models.CharField(
max_length=192,
help_text=_("Administrative Division of land"),
blank=True,
null=True,
)
location=models.CharField(
max_length=192,
help_text=_("Administrative Location of land"),
blank=True,
null=True,
)
sub_location=models.CharField(
max_length=192,
help_text=_("Administrative Sub Location of land"),
blank=True,
null=True,
)
place_identity=models.CharField(max_length=192,null=True)
latitude=models.DecimalField(max_digits=9,decimal_places=6,default=0.0)
longitude=models.DecimalField(
max_digits=9,decimal_places=6,default=0.0)
primary_area=models.CharField(max_length=64,default="")
secondary_area=models.CharField(max_length=64,default="")
parent=models.ForeignKey(
"self",on_delete=models.PROTECT,null=True,blank=True,editable=False
)

area=models.FloatField(
default=0,
blank=True,
validators=[MinValueValidator(0.00)],
help_text=_("Area in Acres"),

```



```

)
perimeter=models.FloatField(
    default=0,
    blank=True,
    validators=[MinValueValidator(0.00)],
    help_text=_("Perimeter in feet"),
)

class Meta:
    """Transfer Request Meta."""

    permissions=(("can_verify_land", "Can Verify Land."),)
    ordering=["-date_created"]

    def title_deeds(self):
        """Return all pre-owned titles."""
        deeds=sys_apps.get_model("land", "TitleDeed").objects.filter(
            Q(land=self)|Q(land=self.parent))
        return deeds

    def current_deed(self):
        """Return the current Land Owner."""
        return self.titled deed_set.exclude(
            date_nullified__isnull=False, nullified_by__isnull=False
        ).filter(
            approved_by__isnull=False, date_approved__isnull=False
        ).exclude(
            signature__isnull=True
        ).exclude(
            signature__exact=""
        ).exclude(
            date_verified__isnull=True, verified_by__isnull=True
        ).last()

    def current_owner(self):
        """Return the current Land Owner."""
        deed=self.current_deed()
        owner=None
        if deed:

```

```

owner=deed.owner
returnowner

defcan_create_owner(self):
    """Can Create Owner.

    Check if can create Owner.
    Only Allow if there is no pending user actions or approvals

    Returns:
        [type] -- [description]
    """
    ifself.current_owner():
        returnFalse
    returnnotself.titled deed_set.exclude(
date_nullified__isnull=True,nullified_by__isnull=True
).exists()

```

