

# Development of Electoral Process System to Leverage COVID-19 Pandemic Risks

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**Abstract:** The electoral process has had challenges in policy as a result of large number of competitive elective positions and COVID-19 pandemic risks. In mitigating these challenges, there is need to incorporate innovations of Information and Communication Technologies in the electoral process so as to have confidence in the electoral management bodies that have always been blamed for the failure of delivering credible and timely election every election cycle that have in many instances resulted into violation of the electoral laws and guidelines that have led to violence in some selected counties. In this research project the emphasis was on investigating the problems and challenges associated with the past electoral process systems that were identified as the ineffective tallying of votes and delay of the elections results in some regions that have vast geographical coverage and/or poor network infrastructure coverage. The analysis is carried on the collected facts and design of the system done that evolve prototype that would lead to improvement in provision of electoral process services. The prototype developed manages the tasks that include registration, appointments, polling, tallying, equipment, suppliers, payments and employees. In insecurity, threats are reduced by enforcement of the encryption and access of only authorized pages as a security measure for emerging threats. The spiral development methodology is adapted in the electoral process system development phases.

**Keywords:** COVID-19, Risks, Leverage, Prototype, Security, Spiral Methodology, Electoral, Voting

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## 1. Introduction

The electoral process framework for transparency, inclusiveness and accountability in managing some or all of the essential elements of the electoral process plays a critical role in managing the process before, during and after election. In this paper we seek to explore some of the key reforms that are necessary for legislation that will bring forth the reforms in the undeveloped and developing countries that includes the consideration of introduction of Information and Communication Technologies in managing the electoral process. This is as a result of the COVID-19 pandemic spread and risks associated with the handling of election materials and equipment which mainly involves touching electoral process equipment and supporting materials or devices.

### 1.1. Electronic Electoral Process System

An electronic electoral process system is considered as the

system that use Information and Communication Technologies (ICT) in providing services in the electoral process that includes registration, tallying votes and retrieval of electoral process documents in timely manner when required for verification and during distributes that can be achieved by cost effective and secure use of Information and Communication Technologies in providing and managing the electoral process services. In particular, the integration of the electoral process components [1] includes managing the following;

- i. Registration of the old and new voters in the electoral services system
- ii. Appointment processing before and during general election voting day
- iii. Employees records
- iv. Suppliers records
- v. Equipment records
- vi. Electoral equipment and consumables payments
- vii. Verification of eligible voters
- viii. Retrieval of electoral process records for viewing

- ix. Provision of unlimited access to electoral process records and services to all stakeholders
- x. Integration of the electoral process system with the births and deaths registration system for managing the eligible voters.

The benefits that are realized as a result of the introduction of the electronic electoral process system includes, reduction of redundancy, reduction of information duplication as there is no more manual voter registration every election cycle thus saving on the resources, reduction on time spent on long queues during voting as now people will be allowed to vote after making an appointment through the system and risks associated with spread of COVID-19 variants will be reduced drastically as there will be minimum sharing of materials and equipment. In designing the electoral system, the aim is to have the operations currently being handled manually to be fully automated to address the concerns that have been witnessed in already existing systems and associated risks due to the emerging challenges like the COVID-19 pandemic.

### 1.2. Statement of Problem

The research project problem is to develop appropriate electoral process system prototype that would store, retrieve and manage records of voter registration, equipment, payment, appointments and cast vote's records in supporting the provision of quality, affordable and secure electoral process services for all stake holders using appropriate and scalable technologies.

### 1.3. Objectives

#### *General Objective*

The general objective of the research project is to study, analyse, design, test and implement an affordable and comprehensive electoral process system to manage electoral processes and records that may be used in countries that are currently using manual or systems that do not meet the secure, maintainable, usable and scalable standards of electoral system.

#### *Specific Objectives*

- i. Observe and identify the weaknesses of existing electoral process systems.
- ii. Design and develop database for the general election voter records for easy retrieval and management during and after election.
- iii. Design fast, reliable, secure, less complex and effective online electoral process system that would store and integrate records of equipment, appointments, registration and payments for effective delivery of electoral process services in undeveloped and developing countries to advance good governance and democracy.
- iv. Develop secure, dependable, efficient, affordable and usable online electoral process system using appropriate and scalable technologies.

### 1.4. System Requirements and Specifications

The system user requirements of the proposed system is intended to bridge the gap resulting from ineffective existing systems that have not met the user expectations. The user requirements for the proposed electoral process system includes the registration of voters, management of voters records, employees records, suppliers records, equipment, payments, and appointments. In the proposed electoral process system the system requirements specification [2] includes the following;

- i. The user shall be able to register as a voter, supplier or employee on a presented electronic form where the user is required to fill biodata.
- ii. The system shall allow the user to search information on voter records, supplier records, employees' records, payment records and equipment records.
- iii. The user shall be able to register new voters, equipment, employees and suppliers.
- iv. The user would conveniently make appointments or cancel appointments.
- v. The system would allow payments of salaries, payments of lost equipment and supporting devices from user commercial accounts.
- vi. The stored biodata shall be altered by filling the update electronic form whenever there is change or variation of the current compared to the initial submitted data during registration.
- vii. The system shall generate reports on request and users shall be allowed to view the appropriate relevant records and information.
- viii. The system shall be available 24/7 for the users.
- ix. The system would meet the standards of good software qualities described simply as maintainability, dependability, efficiency and usability characteristics.

### 1.5. Justification of the Study

The research project is commenced to leverage, first, the emerging COVID-19 pandemic variants in which the transmission can be reduced by limiting number of persons gathering together or forming long queues during registration or voting. Secondly, limiting the sharing of materials and equipment that have been found to be largest contributor of high transmission of COVID-19 pandemic variants among the population according to the COVID-19 task force guidelines and ministry of health protocols. Thirdly, the electronic registration will limit multiple registration that may jeopardize the correct and accurate electoral process exercise as there may be malpractices during voting. Finally, the results will be transmitted accurately and in good time for the final tallying of the competitive democratic election of representatives.

## 2. Literature Review

The voting process is considered as process that allows group of individuals make political, social or public decisions

of electing representatives in a competitive process based on the concept of majority or plurality [3]. Alternatively electronic voting system is on in which the recording, casting and counting of votes involve Information and Communication Technology [4]. There are four categories of electoral process voting systems that include, first, the direct recording electronic voting machine that are intended to provide physical evidence of the votes, second is the optical mark recognition systems which are based on scanners that can recognize the voter's choice on special machine-readable ballot papers, third, electronic ballot printers, that are devices similar to a direct recording electronic machine that produce a machine-readable paper or electronic token containing the voter's choice in which the token is fed into a separate ballot scanner which does the automatic vote count and forth, the internet voting systems where votes are transferred via the internet to a central counting server in which votes can be cast either from public computers or voting polling stations or internet connected computer accessible to voter [5, 6].

The functional requirements of the system design for these systems are based on atomicity, uniqueness and principle of reducing redundancy. Electronic voting is considered to be efficient and cost effective procedure as it attracts the modern young voters that has been found to attract high rates of participation [7]. However the concern of most electoral management boards are mainly concerned on the compliance of the electronic systems with the existing framework governing general elections [7, 8]. The developers therefore are concerned in identifying the fundamental problems associated with adequate level of security that includes anonymity, authentication, data security and tractability [9], [10]. The main objective of the electronic system is to provide up-to-date electoral process services at all times with minimal errors [11].

In most of the developed systems the emphasis has been reduced to tallying of the competitive general elections for representation seats but proposed developed system incorporates the services of managing employees, suppliers, equipment and appointments records that will leverage the COVID-19 and its variant risks. In particular the proposed system security and access of services and resources from credible and recognized sources would be top priority. The system will be designed and developed to address the following challenges [1];

- i. Increase the transparency of electoral processes such that the records will be easily available for viewing and comparing for citizens and election monitoring organizations.
- ii. Improve the effectiveness of an election management body by allowing voters to check whether they are eligible registered voters so as to correct the anomalies before the elapse of set deadlines.
- iii. Increase voter participation in elections especially for the marginalized populations since such populations will have a convenient system that will enable them to easily register to vote during the general elections or by elections.

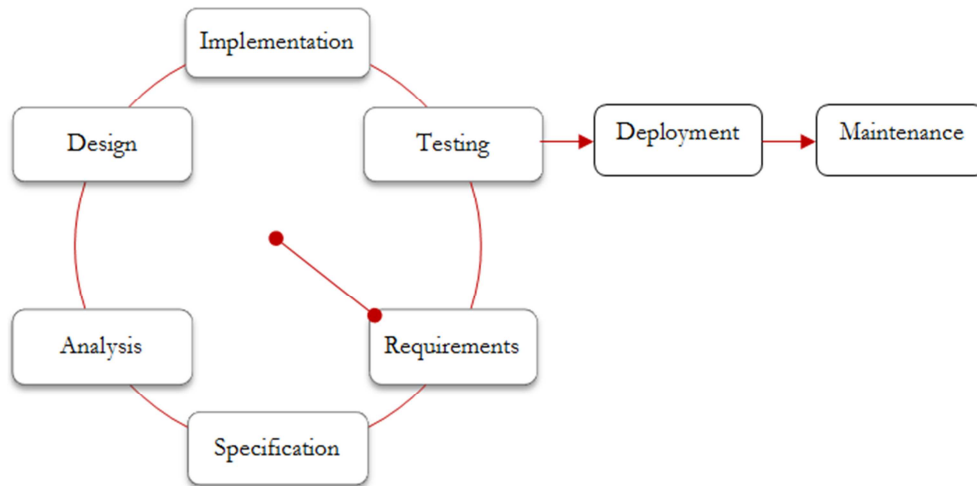
- iv. Increase stakeholders engagement as the results of individual polling stations are released in time and tallied with other polling stations for the voters to compare votes tally in polling stations for candidates and parties.
- v. Improve the inclusiveness of traditionally marginalized groups as empowerment organizations easily access information to advocate for participation of such groups.
- vi. Reduce tension since the election monitoring organizations can easily tally competitive election results that are timely and make early projections of the results for the parties and candidates that will reduce anxiety among the electorate and candidates.
- vii. Generate new insights on the strength of parties in different regions and organizations tasked with the duty of monitoring hot spots of violence will be able to compile reports for the necessary action to be taken to avoid any political violence.

### 3. Methodology

In developing well-structured and quality software product that is delivered in good time, document that outlines the phases and detailed description in each of the process phases that the developer wishes to adopt in the system development process is prepared and documented. The document usually prepared before the development of the software product acts as guiding document that may be used in software product development. A well prepared document will indicate and give evidence of technical understanding of the electoral process system that need to be developed that will ultimately meet the user's requirements. The preparation of this document will therefore enable us to achieve the objective of producing quality software that is reliable, usable, reusable, maintainable, portable, robust and efficient. The classical phases of the software development process include requirements, specification, analysis, design, implementation, testing, deployment and maintenance. The selection of the software development process methodology is an important decision that programmers have to make as the methodology lays down the rules that delivers a credible and well-structured working system product. The methodologies that evolve systematically and predictable system software are the spiral methodology and iterative methodology described below [12].

#### 3.1. Spiral Methodology

This is the development of system that is flexible compared to the waterfall methodology. In spiral methodology there is an attempt to produce a complete system product on completion of every cycle where each subsequent cycle involves improved requirements, specification, analysis, design, implementation and testing phases.



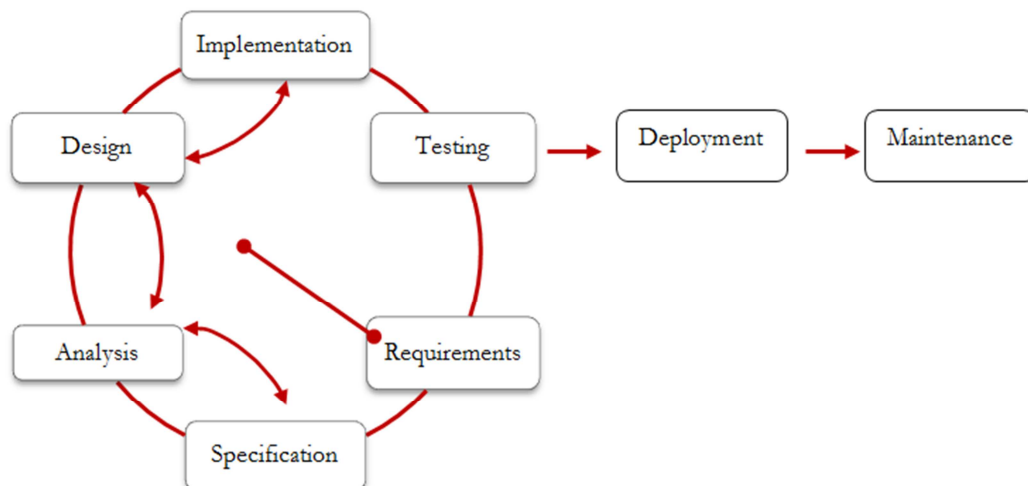
*Figure 1. Spiral development methodology.*

In the first cycle, the first version of the system that runs but may not be perfect is made available and documented. The process is repeated in the second, third and subsequent cycles until a satisfactory system product is produced and documented. When all the phases are completed to the acceptable standards and documented the product is then deployed and finally the maintenance phase is carried out that will gradually meet the users' specification [11] if it is successfully completed. The spiral methodology mainly focuses on adaptability and is suitable methodology whenever system developer wish to reduce overheads, for instance, the rationale, justification, documentation and development meetings. In particular the spiral methodology is favourable when system requirements are changed from the initial requirements as a result of change of mind in the part of the client or due to change of technology. The process phases of requirements, specification, analysis, design,

implementation, testing, deployment and maintenance are depicted as shown in Figure 1.

### 3.2. Iterative Development Methodology

The iterative methodology is common in modern software development processes as it put more emphasis on repetitive refinement and transformed through analysis, design and development phases. The phases of analysis, design and implementation improvements are gradually introduced and the developer is allowed to proceed to the next phase or return to the previous phase as need arises. The iterative methodology is however suitable for development of systems that are relatively small that do not require evolution and maintenance. The iterative methodology process stages of requirements, specification, analysis, design, implementation, testing, deployment and maintenance are depicted as shown in Figure 2.



*Figure 2. Iterative development methodology.*

There is one common weakness to the iterative methodology that will make it unpopular, that is, it does not have good documentation and therefore not well structured

that eventually would make the development of the system difficult to evolve and maintain. In this project we would adopt the spiral methodology and not iterative methodologies

due to its strengths that include the following;

- i. When you are handling expensive and complex projects, risk management is a must. In this type of model, risk management is easy, moreover, spiral model has the ability to make any software testing project transparent.
- ii. The customer can see and review the test at different stages.
- iii. The projects can be separated into groups to make the management of the various components easy and manageable.
- iv. The documentation is systematic and can be controlled for better management.
- v. The project development will be well planned and more realistic as development progresses.

In the development of the proposed electoral process system the first phase would be to identify the electoral system requirements and specification once the system objectives have been specified. This is followed by the system analysis phase where the use cases and actors are identified and modeled. Since the methodology chosen is spiral, testing will be run after the development process. When the design phase is complete and documented, it is followed by the implementation phase where the design is translated into algorithms and the source code. Again during the implementation phase, the phases of requirements, specification, analysis and design are refined to improve the software product. The testing phase commence when all the phases of requirements, specification, analysis, design and implementation are complete and documented. This phase involves the evaluation of the product using the test data that would be stored in the database. The faults that are identified in this phase are corrected as well as the revision and refinement of the previous phases to reflect the new development changes in the electoral process system product.

In the development of the electronic electoral process system the first phase would be to identify the requirements and specification once the system objectives have been specified. This is followed by the system analysis phase where the use cases and actors are identified and modeled. The next phase that follows on the completion of the analysis is the design phase in which the relations and relationships are modeled, the requirements, specification and analysis process phases are also refined and revised in line with the spiral methodology. When the design phase is complete and documented, it is followed by the implementation phase where the design is translated into algorithms and the source code. Further, the phases of requirements, specification, analysis and design are refined to improve the software product. The testing phase commence when all the phases of requirements, specification, analysis, design and implementation are complete and documented. This phase involves the evaluation of the product using the test data that would be stored in the database. The faults that are identified in this phase are corrected as well as the revision and refinement

of the previous phases to reflect the new development changes in the electoral process system product.

### **3.3. System Constraints and Challenges**

The electronic electoral system is expected to have constraints and challenges that include but not limited to connectivity challenges as a result of poor telecommunication infrastructure, high internet connection costs and lack of access to international bandwidth in most of the undeveloped and developing countries, lack of well trained personnel in Information and Communication Technology skills to effectively provide the services and maintain the system. However, since there has been an attempt to introduce such system in managing the electoral process in some limited countries for instance Kenya and Ghana, there are few trained personnel and experiences that will enable the electoral management bodies to learn and share experiences for better development and management of the process.

## **4. Analysis and Design**

### **4.1. Analysis**

The analysis of the existing electoral systems and processes play a great role in developing the election software as it brings the insight on the core system specifications. The requirements specifications were modeled using Unified Modelling Language [13] techniques. The preferred unified modelling language technique in object-oriented analysis is the use case diagram. In collecting and gathering information on the requirements of the electronic election system various methods were considered for the purpose that includes, interviewing service providers, political party officials, candidates of various representation positions, observation of the past electoral processes, interviewing and holding discussions with experts in matters of electoral processes both local and international. The study of election documents, interviews of stakeholders and observation of the systems currently in operation in many undeveloped and developing countries reveal that the systems are inefficient in delivery and lack subsystems that effectively manage appointment schedules, payroll, payment for services, payment of equipment and managing the election results and records [14]. The proposed electronic electoral process system is expected to address the current faults and incorporate the concerns of the stakeholders and users so as to evolve an efficient, credible, scalable and secure system.

The construction of the use case diagram represents the modelling of use cases identified to capture the system specifications that are feasible to individuals or subsystem in the proposed electronic electoral process system. The individuals and subsystems that interact with the identified use cases usually referred to as actors in the proposed electoral process system are classified into three main categories of non-voters, eligible voters and employees. The specific actors

identified in the proposed electronic electoral process system includes but not limited to non-voter, voter, accountant,

administrator, employee and supplier. The use cases are modeled as represented in the use case diagram in Figure 3.

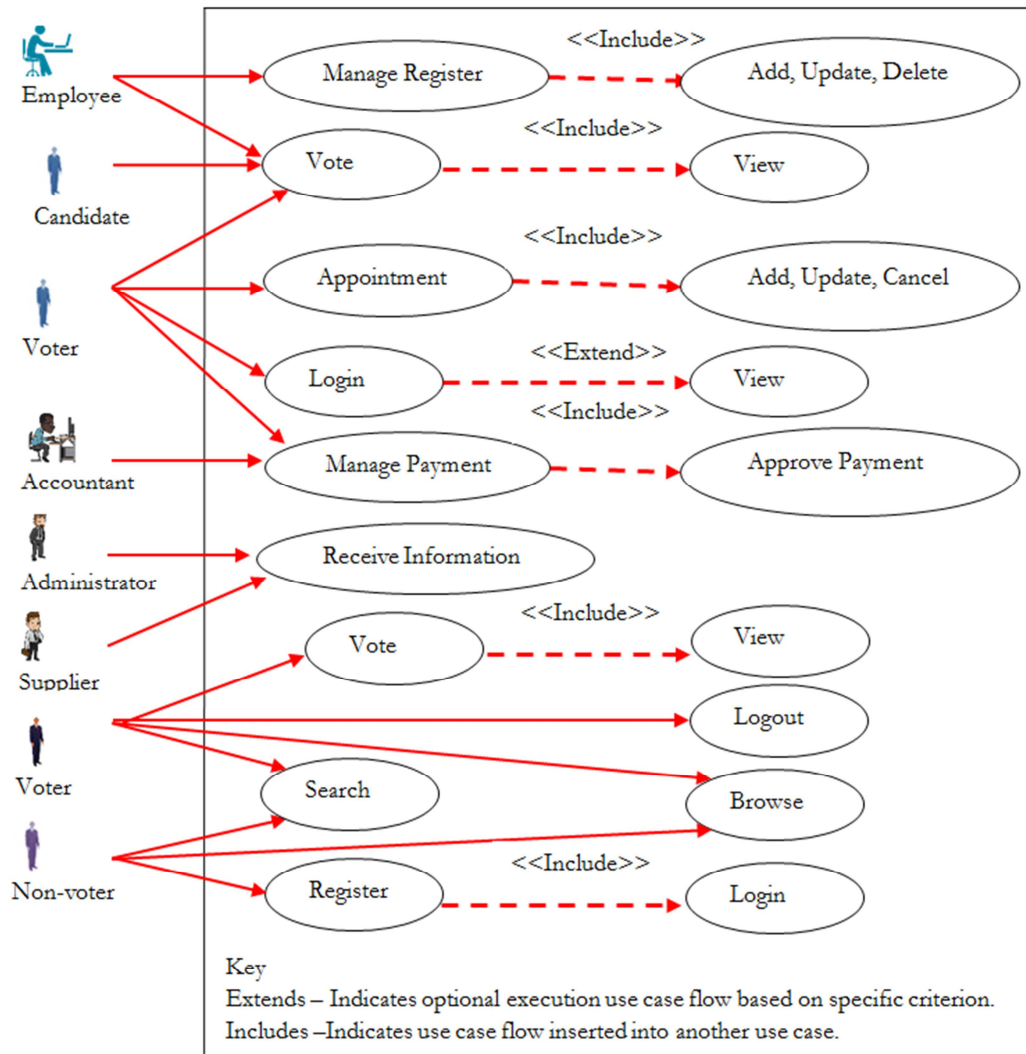


Figure 3. Use case diagram.

#### 4.2. Design

The design of the system is the critical system development phase where the system specifications are modeled using class diagrams and construction of user interface diagrams that capture inputs, editing and displaying of required user system records as per the needs and specifications. Since the system will require the records storage, the class diagrams will then finally be translated into relations while the attributes will be the columns in developing the database. The class diagram is a Unified Modelling Language technique commonly used in developing object-oriented solutions. In designing the anticipated solution, the classes, attributes and operations for the electronic electoral process system are identified and documented. The identified classes includes the voter, employee, candidate, appointment, account, payment, supplier and administrator.

The process of using set of restrictions to exclude certain

undesirable properties in the design commonly referred to as normalization is important in the design stage and therefore given priority in system design that leads to well-designed database by reducing the amount of duplication, storage space requirement and update anomalies that help in improving the natural representation of records in the database. In order to construct the class diagrams, the classes and relationships are represented in the class diagram. All the possible relationships are considered and all those relations that are found to be many-to-many are further decomposed to one-to-many while those that are found to be one-to-one relationships are discarded from the final class diagram.

The decision on the selection of data types for the attributes depends on the size of the value stored and the nature of manipulation expected on the data value. If the data value is involved in computation then integer is appropriate if the data value is a whole number while double is selected for the data value that comprise of both whole number and fractional part. The data values that are

not used for manipulation for instance the identification data values the string data type are commonly used because they have good concatenation properties and wide range of data values as they use all types of characters except the special characters.

### 4.3. Sequence Diagram

The sequence diagrams are constructed to validate the logic in the description of electoral process system and help in detecting unforeseen defects in the design. In the electoral

process, they are constructed to validate new voter registration, voter login and employee login as shown in Figure 4, Figure 5 and Figure 6 respectively. In Figure 4 the new-voter makes a request to register as new voter by clicking the register button on the home page interface. The new voter then input personal details that includes voter number, national identification, name, address, phone and email. The electronic election system validates the new member details and sends feedback to the new voter that the registration is either successful or unsuccessful.

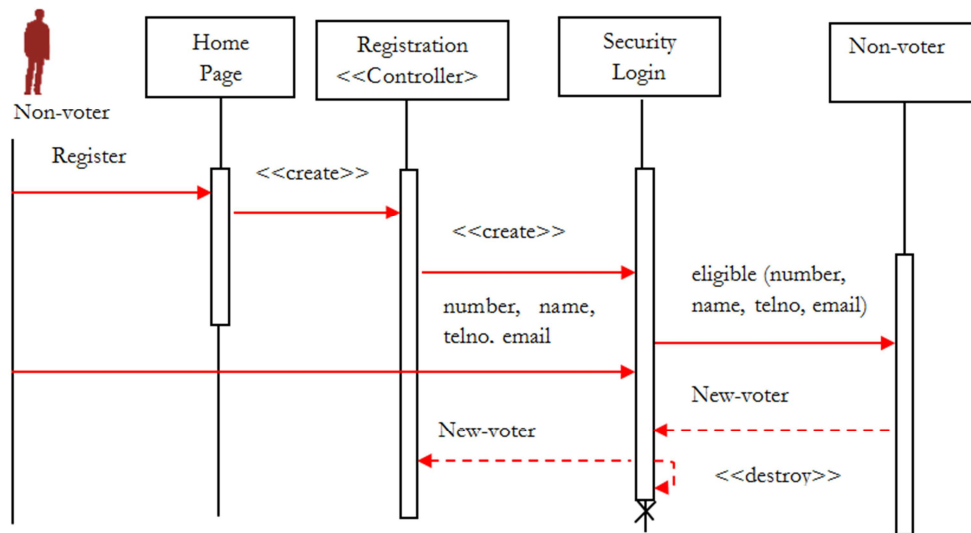


Figure 4. New voter registration sequence diagram.

In Figure 5 the voter makes appointment request by clicking the login button on the home page, then input the username and password. The electoral system validates the

member login details and gives feedback to the voter that may be the main voter page or login unsuccessful message.

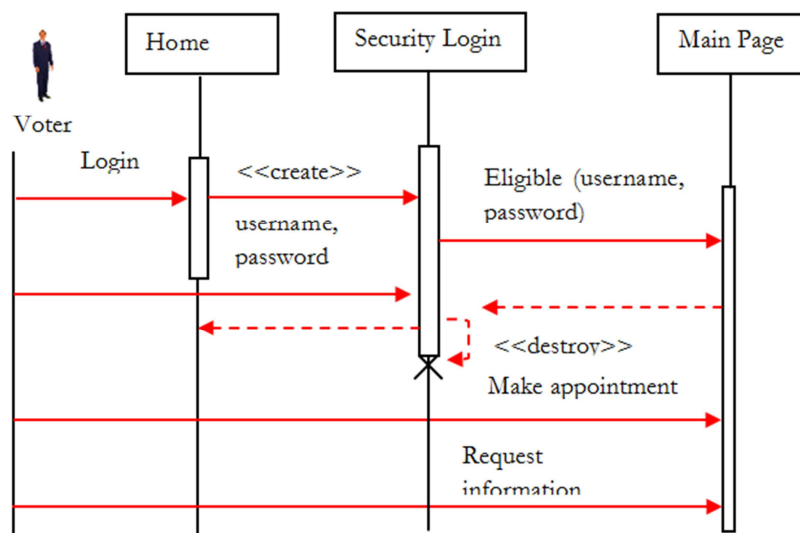


Figure 5. Registered voter login sequence diagram.

In Figure 6 the employee who may be the election clerk, returning officer, accountant or administrator requests members' records details. He/she first clicks the login button on the home page and then inputs the username and password.

The system validates the employee login credentials then gives feedback to the employee that may be main page on successful login if the credentials were correct or homepage if login was unsuccessful due to incorrect credentials.



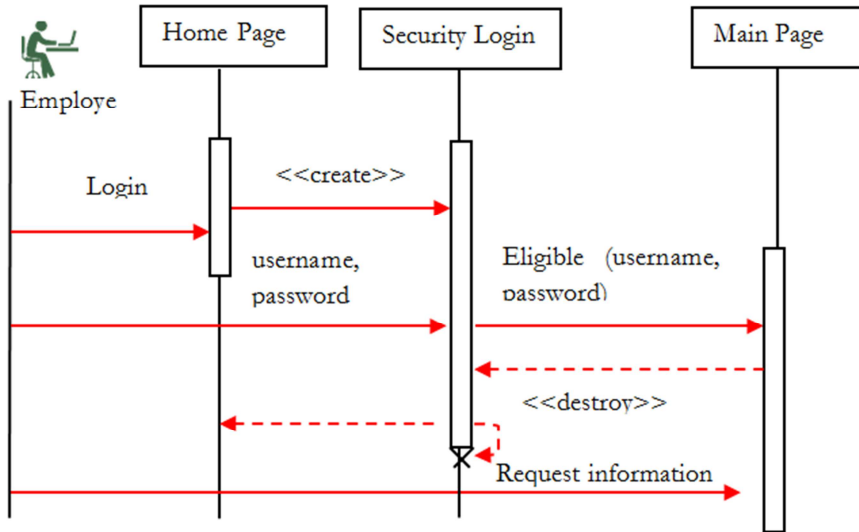


Figure 6. E-Election employee login sequence diagram.

#### 4.4. Database Development Design

The database development is an important electoral process system development phase that requires well planned and properly thought out set rules and standards in order to evolve quality, consistent, secure and well-structured system. A poorly designed database leads to inconsistency, breach of privacy, redundancy and loss of business if the database does not meet the specifications, targets and objectives for which it is designed, that are broadly given as the ability to support relationships among the relations, provide solution to problems for which they are designed, impose integrity constraints, improve efficiency and accommodate emerging challenges. The hierarchical, network, relational database and object-oriented relational database models are commonly used in developing the databases. In this research project, the relational database model is adopted for development due to its strengths that includes storage of standardized data format, simultaneously access of the consistent data, requires less memory due to storage of data free of redundancy and

incorporates data integrity features in its design that are adequately enforced [13]. The development process is systematically carried in two phases, that is, the logical and physical designs as described below.

##### 4.4.1. Logical Design

In the logical design phase the main entities and the relationships between the entities are identified and an entity-relationship diagram constructed which is a useful tool in modelling relations and relationships. In constructing the entity-relationship diagram for the electronic electoral process system, first identify the concept about which the data of name, identification or address for instance is stored referred to as entities that may either be object, institution or person. The entities identified for electoral process system includes payment, equipment, account, appointment, employee, register, ward, party, candidate, polling and supplier. The relationships between entities indicates the sharing of data between entities that may either be one-to-many or many-to-one as shown in Figure 7.

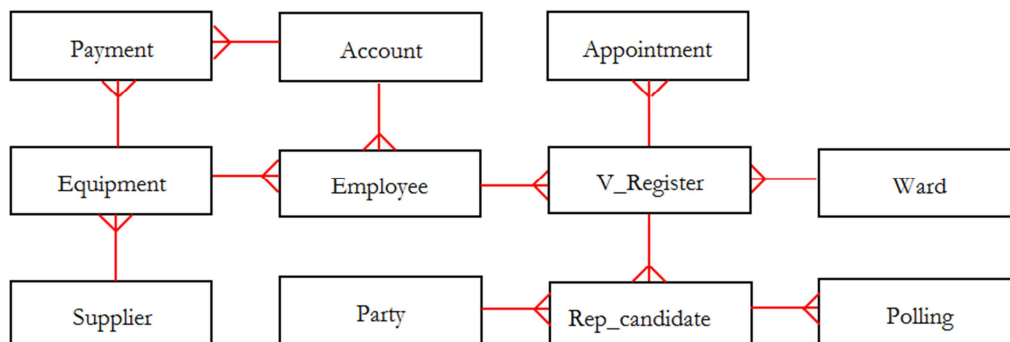


Figure 7. E-Electoral process entity-relationship diagram.

The attributes of each and every entity or relation are identified by observing existing electoral systems, documents and reports of such systems and the requirements

specification of the proposed electronic electoral process system. The entity relationship diagram is crucial as it relates and validates the relationships between the relations that



guides in making a decision on whether additional relations or discarding relations is appropriate. The relations normally discarded are ones that have one-to-one relationship while the relations with many-to-many relationships are remodeled to include additional relations since the many-to-many may lead to undesirable effects in the design of the database. The modelling of relations, attributes and relationships between the relations is represented in the conceptual model shown in Figure 8.

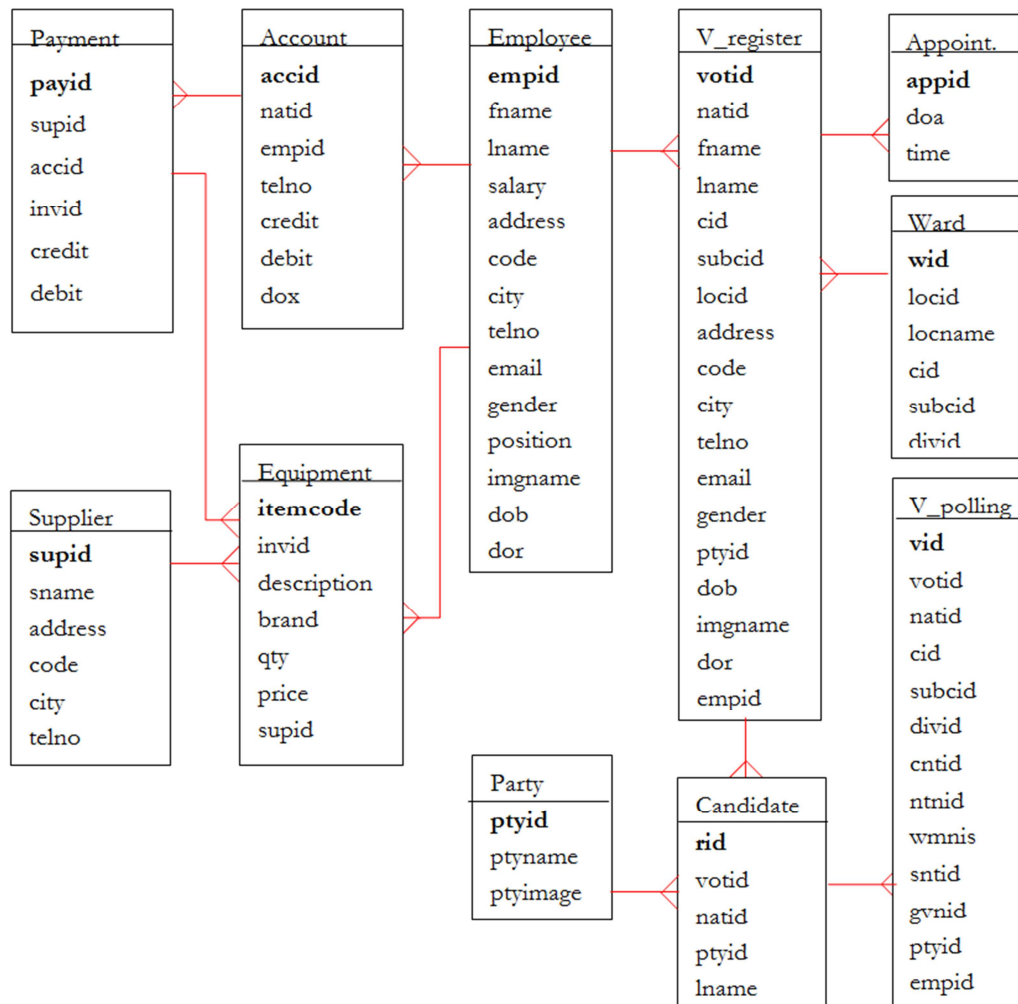


Figure 8. E-Electoral process conceptual model.

In instances where there are more than one candidate key, randomly pick one of them, but if there is no unique candidate key, then explore the possibility of combining two or more attributes or include a new attribute in the relation that will have the unique property for every row or record. In order to relate the relations, we could include the primary key attribute of a relation in relation or relations that we wish to relate the relation. This would enable the user to extract related information more efficiently from relations where it is currently being held. The representation of the relations, primary keys and foreign keys of the proposed electronic electoral system is depicted as schema diagram shown in Figure 9.

In register relation all the possible attributes that are unique in every row are considered in order to determine the primary

#### 4.4.2. Physical Design

The representation design of the data in the physical representation of the logical design in a system is referred to as the physical design. The first task in the design is to identify attributes that are unique for every row in the relations, then based on personal preference, judgement and convenience, select the primary key for each of the relations from the attributes of the relations.

key. The attribute voter number and national identification number are the only possible candidate keys. The voter number attribute is then selected as the primary key for the register relation. The next relation employee has candidate keys of employee number, telephone and email. The employee number is conveniently selected as the primary key for this relation. The supplier relation has the supplier number selected as the primary key as well. In the equipment relation, we have the invoice number, item code, description, brand and price as the possible candidates. The item code is conveniently selected as the primary key in the equipment relation. The candidate relation has representative number, voter number and national identification number as candidate keys. The candidate representative number is selected as the primary key.

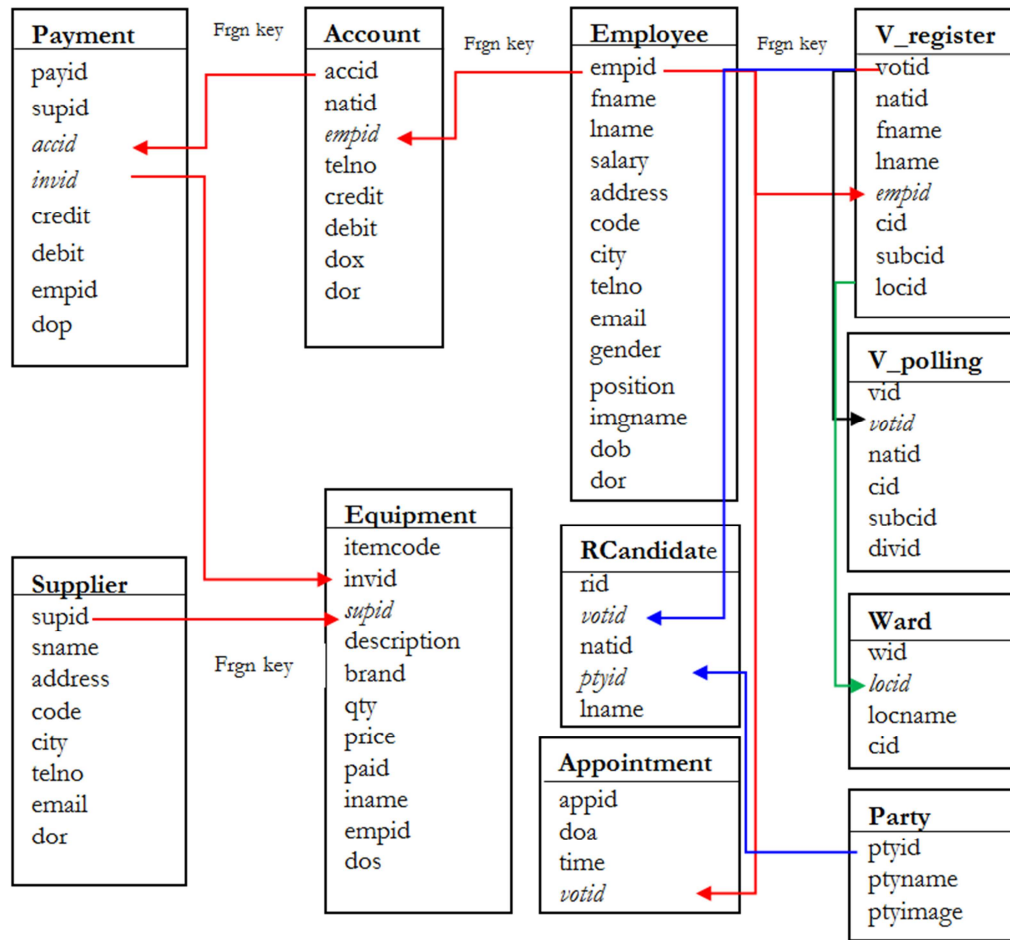


Figure 9. E-Electoral process schema diagram.

The party relation has party number as the only possible primary key and therefore it is selected as the primary key for the party relation. The ward relation has ward number that is unique and therefore becomes the primary key for ward relation. In the payment relation, we have the payment number automatically generated as the only possible primary key in payment relation. The account relation has account number as the only possible primary key and therefore selected as the primary key. The appointment relation has appointment number as the only possible primary key and therefore it is selected as the primary key for the appointment relation while polling has polling number automatically generated and selected as the primary keys as well. In relating the relations directly, the foreign keys are established. The first relation payment can be related to account relation by including the account number in the payment relation. The second relation employee can be related to the account, register and equipment relations by including the employee number in the account, appointment and equipment relations. The supplier relation can be related to the equipment relation by including the supplier number in the equipment relation. The register relation is related to appointment and polling relations by including the voter number in the appointment and polling relations while the ward relation is related to register by including the location

number in the register relation. In order to take into consideration the data precision, storage memory requirement and efficiency in processing, appropriate size and data type for each of the columns in the physical model design is given a priority consideration in database design development. In addition to selection of correct data types, the integrity constraints are carefully enforced.

#### 4.5. User Interface Design

The design of user interface requires skills and input from various expertise in software development that includes the graphic designers, system analysts, programmers, engineers, information records personnel, accountants, managers and stakeholders [15]. In this research project the user interface was developed based on the user requirements specifications in which the main guiding principles considered includes the system qualities of navigation, accessibility, visibility, usefulness and feedback [16]. In the initial stages of developing the user interface, the sketches are drawn based on the use cases of login, search, add, update, delete and display voters' records to stakeholders. Since the actors have varying privileges, the pages are designed for categories of users that are broadly classified as non-voters, voters and service providers.

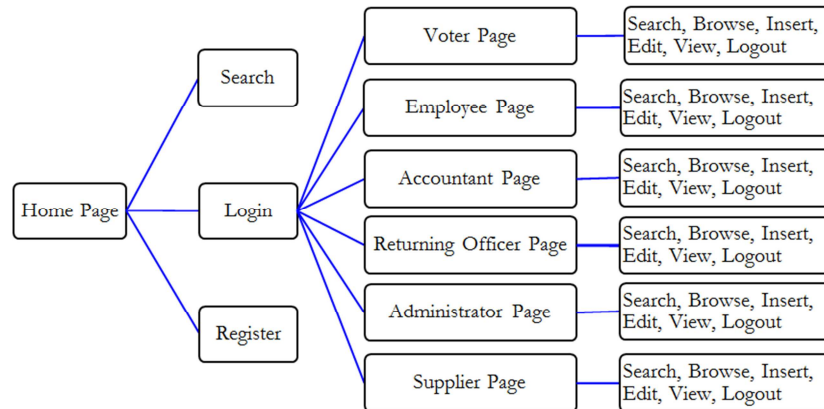


Figure 10. Electronic election system pages design.

The service providers are further categorized as employees, suppliers, accountants, administrators, clerks and returning officers. The actors are assigned appropriate interfaces as a measures of making the system secure in order to reduce the chances of unauthorized access to records and services. In the home page usually accessed by non-voters, voters and service providers, the user is allowed to browse, search, register or login. Once the individual seeking the

services has registered, he/she can now access the main page as depicted in Figure 10 using the authorized personal security credentials. The home page sketch in Figure 10 would then be designed in order to obtain home page that the user would use to search, browse, login or access the home page menu where the user can click the buttons to display the registration form for registration as a voter or service provider as shown in Figure 11.

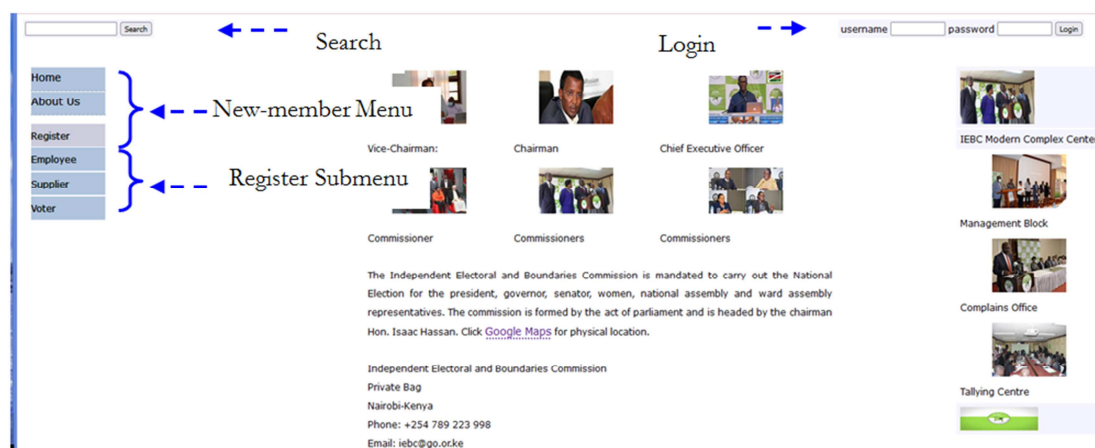


Figure 11. Election electronic system home page interface.

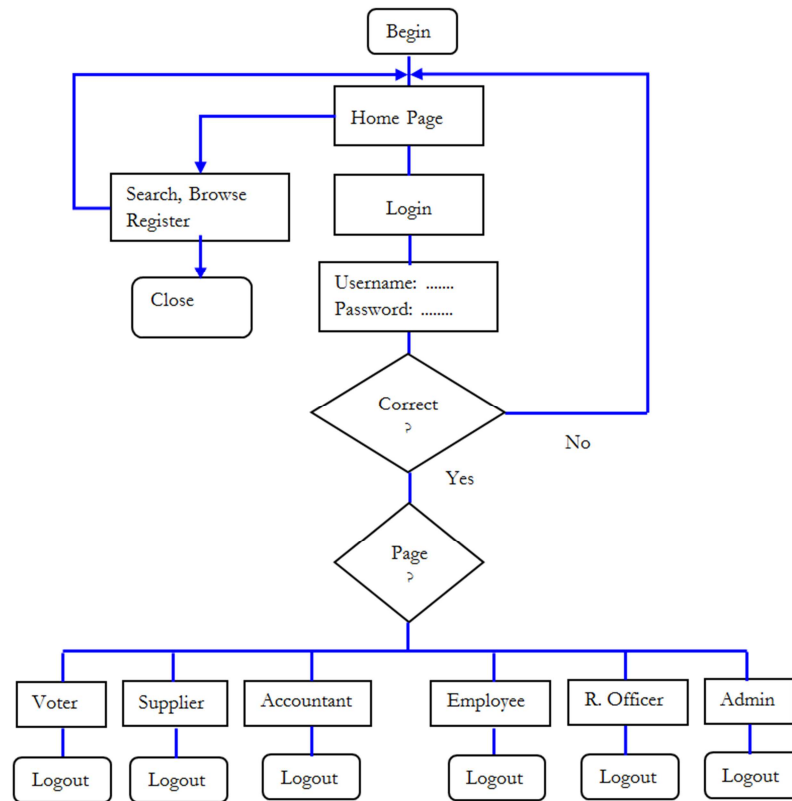
Figure 12. Registration of new voter.

If the user wishes to register as a voter, then he/she would click the register button to access an electronic registration form shown in Figure 12 where the user would fill the

personal details of national identification number, first name, last name, address, phone, email and party details. On completion, the user would then click the register button to

submit personal record or click cancel to discard the filled record. If all the information is correct and complete, the user would be sent a notification of successful registration otherwise the user would be notified of unsuccessful registration. The correct information would then be processed by the administrator who will accept or reject the request of

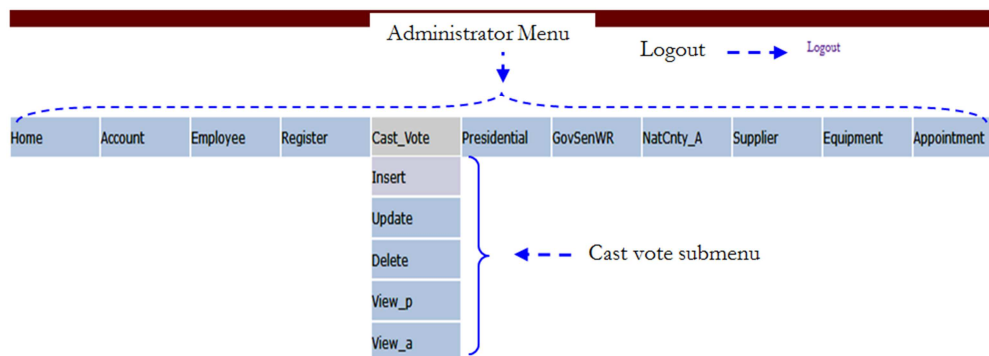
registration. If the administrator approves the request, the user would be notified of the acceptance of registration request and would also be sent the voter number, username and password through the email address that would be used in subsequent system login, identification and reference whenever the user seeks electoral system services.



**Figure 13.** Login design.

In order to login, the user need to click the login button on the home page, then type username and password and clicks login button. If the username and password are correctly filled, the user will access the voter, supplier, accountant, employee, returning officer or administrator page if the login credentials are correct as depicted in Figure 13. If user login is successful, he/she will access the main page that will have the options of search, logout and main menu and respective sub menu depending on the user login credentials that may be of voter, supplier, accountant, employee, returning officer or

administrator. The administrator main page menu has home, account, employee, register, cast\_vote, presidential, governor, senate, national, supplier, equipment and appointment. In the cast vote menu we have sub menu insert, update, delete or view as depicted in Figure 14, where the administrator would insert new records, edit, delete or display cast vote records. If the administrator wish to add or edit or delete or display then he/she need to click the appropriate option. The insert, update, delete, view tally and view cast votes records interfaces are as shown in Figures 15 to Figure 19 respectively.



**Figure 14.** Registered administrator main page interface.

**Cast Vote August 9 2022 General Election**

*VoterID:	<input type="text"/>	*National ID:	<input type="text"/>
County ID:	<input type="text"/>	Sub_county ID:	<input type="text"/>
Division ID:	<input type="text"/>	Location ID:	<input type="text"/>
County Ass. ID:	<input type="text"/>	National Ass ID:	<input type="text"/>
WomenR ID:	<input type="text"/>	Senator ID:	<input type="text"/>
Governor ID:	<input type="text"/>	Presidential ID:	<input type="text"/>
Employee ID:	<input type="text"/>		

Register Cancel

Figure 15. Insert vote cast record.

**Update Cast Vote Record**

*Voter ID:	<input type="text"/>	*National ID:	<input type="text"/>
County Ass. ID:	<input type="text"/>	National Ass ID:	<input type="text"/>
Women_R ID:	<input type="text"/>	Senator ID:	<input type="text"/>
Governor ID:	<input type="text"/>	Presidential ID:	<input type="text"/>

Update Cancel

Figure 16. Update cast vote record.

**Delete Cast Vote Information**

*Voter ID:	<input type="text"/>
*National ID:	<input type="text"/>

Delete Cancel

Figure 17. Delete cast vote record.

Presidential Candidates Sub_County Votes										
VotID	NatID	FName	LName	PID	PtyName	CID	CName	SID	SubcName	Ttl
19020101001	N1001	Alfred	Mutua	01	Jubilee	19	Nyeri	02	Kieni East	1
19020101002	N1002	Adida	Abduba	02	TNA	19	Nyeri	02	Kieni East	1
19020101003	N1003	Martin	Wambora	03	UDA	19	Nyeri	02	Kieni East	1
19020101004	N1004	Hassan	Joho	04	ODM	19	Nyeri	02	Kieni East	1
19020101005	N1005	Charity	Ngilu	05	PNU	19	Nyeri	02	Kieni East	1
19020101006	N1006	Wycliffe	Oparanya	06	Wiper	19	Nyeri	02	Kieni East	1
19020101007	N1007	Mhukisa	Kituyi	07	IND	19	Nyeri	02	Kieni East	1
19020101001	N1001	Alfred	Mutua	01	Jubilee	46	Nyamira	01	Borabu	1
19020101002	N1002	Adida	Abduba	02	TNA	46	Nyamira	01	Borabu	2
19020101003	N1003	Martin	Wambora	03	UDA	46	Nyamira	01	Borabu	2
19020101004	N1004	Hassan	Joho	04	ODM	46	Nyamira	01	Borabu	2

Figure 18. Display tally presidential county cast votes records in sub-counties.



Ward Cast Votes Records										
VotID	NatID	FName	LName	CID	CName	SID	SubCName	DID	DivName	LID
46010101001	N4001	Fred	Matiang'i	46	Nyamira	01	Borabu	01	Ekerenyo	01
46010101002	N4002	Bakary	Traore	46	Nyamira	01	Borabu	01	Ekerenyo	01
46010101003	N4003	Kpangay	Mohamed	46	Nyamira	01	Borabu	01	Ekerenyo	01
46010101004	N4004	Mary	Wausi	46	Nyamira	01	Borabu	01	Ekerenyo	01
46010101005	N4005	Aurise	Niyoyunguruza	46	Nyamira	01	Borabu	01	Ekerenyo	01
46010101006	N4006	Motlomelo	Monaheng	46	Nyamira	01	Borabu	01	Ekerenyo	01
46010101007	N4007	Mafukidze	Portia	46	Nyamira	01	Borabu	01	Ekerenyo	01

*Figure 19. Display selected county cast voters records.*

## 5. Development Process Cycle, Conclusion and Further Research

### 5.1. Development

The development of the electoral process system involved the implementation of the five phases of secure software development life cycle that includes the phases of implementation, testing, security, deployment and maintenance described below;

- Implementation - The implementation of the electoral process system involved writing source codes of login, search, validation, registration, insert, edit, delete and display of records.
- Testing plan - The testing strategy plan of the system was done using the by elections for the vacant seats as a result of electoral process challenges or death or recall of representatives due to non-performance.
- Security - The electoral process system would store voters, suppliers and employees and confidentiality of such records is given priority to avoid unauthorized access or virus attacks. In order to achieve this, awareness is done on dangers and effects of the virus attacks. The electronic system users are further encouraged to use updated antivirus software. The second security measure is to make sure authorized persons access system services by implementing the using of access login credential whenever a person seeks system service to avoid sabotage.
- Deployment - The deployment of the electoral system product involves the distribution and installation of the product in servers that are secure in protected premises.
- Maintenance - The maintenance of the software involves identification of the faults and making the software for the tasks. However such faults are minimal as the components have well outlined and documented tasks that are well thought out and tested before deployment of software product.

### 5.2. Conclusion

The main aim in this research project was to demonstrate how the electoral process system would be used to manage the electoral process in both the general elections and by elections in all the competitive elective positions of presidential, governor, senate, national assembly, women representative and county assembly in governments that have not embraced technology during elections in the past. The designed and developed electoral process system prototype is designed and developed in order to improve and manage electoral process records and services. In particular, the prototype could be considered in managing the following tasks and services;

- Allow registration of voters, employees and suppliers who are considered to seek the electoral process services in undeveloped and developing governments that are currently using the manual electoral process systems.
- Allow voters to make appointments during registration and election period in order to avoid the crowding of voters in the polling centers in order to follow and promote the COVID-19 protocols as provided by the ministry of health.
- Able to efficiently manage voters' election records.
- Allow retrieval of the election records in the instances of disputes that arise after the election, that is, for the petitions.
- Allow the management of employees, suppliers and equipment used before, during and after the competitive elections.

### 5.3. Further Research

In advancement of technology we propose to have the following technology incorporated in future election systems;

- The voters would access electoral process services from the hand-held portable electronic devices.
- The election tallying services would be available 24 hours during the entire duration of the electoral process at the convenience of candidates, stakeholders and employees.

(c) All services would be integrated such that the registration of births, registration of deaths and voters records would be harmonized in order to have updated records of voters that would give the correct number of eligible new voters and actual registered voters for planning and accurate allocation of resources for the electoral process when making budgets for approval.

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