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DECLARATION

I declare that this project work as presented in this paper is my original work and has not been presented anywhere else for any degree, diploma or award.

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Firstly, I would like to thank God for giving me this life and the ability to do this project. To my parents who have supported me in every means possible. To my Supervisors who have given me new and fresh perspectives, Thank You. And Finally my friends who have criticized my work and given me ideas, thank you.

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ABBREVIATIONS

CAGR   Compound Annual Growth Rate

AGM   Annual General Meeting

EGM   Extraordinary General Meeting

USSD   Unstructured Supplementary Service Data

CDSC   Central Depository & Settlement Corporation

PLC   Public Listed Company

KCB   Kenya Commercial Bank

Q & A   Question and Answer

DFD   Data Flow Diagram

IDE   Integrated Development Environment

CHAPTER ONE: INTRODUCTION

1.1   Introduction:

The process of voting in a corporation can be quite tedious for shareholders, not only due to the extensive information that needs to be reviewed but also due to the cost and security issues that arise with traditional voting methods. The cost of mailing and printing the financial documents and information packages can be significant for the corporation and may not be environmentally friendly.

Additionally, traditional voting methods can be vulnerable to fraud and errors, making it difficult to ensure the accuracy and integrity of the voting process. Many shareholders often choose to vote by proxy, which requires them to appoint a representative to attend the annual general meeting and vote on their behalf. This process can be time consuming, as it requires shareholders to communicate with the proxy and ensure that the proxy will vote in line with the shareholder's wishes.

With blockchain technology, a blockchain-based voting system could offer a more secure and cost-effective solution. The decentralized nature of blockchain technology ensures that the voting process is tamper-proof, and the use of smart contract technology can automate the voting process, reducing the need for paper-based documents and the costs associated with mailing and printing.

This can also increase the trust and confidence of shareholders in the outcome of the voting process which in turn increases voter turnout and engagement, as it allows for remote voting and makes the voting process more accessible to a wider audience. This can also lead to a more representative and democratic decision-making process.

A blockchain-based voting system for corporations has the potential to provide a secure and transparent method for conducting voting. It can improve the accuracy and integrity of the voting process while also increasing voter engagement and participation.This is why many companies

are exploring and implementing blockchain-based voting systems as it can potentially solve the problems and issues associated with traditional voting systems in corporations.

1.2   Background of the Study:

1.2.1   Background

Blockchain-based voting systems have been gaining attention in recent years as a potential solution to enhance the security and transparency of voting processes. According to a report by Grand View Research, the global blockchain voting market size is expected to reach USD 441.5 million by 2025, growing at a compound annual growth rate (CAGR) of 61.5% from 2020 to 2025.

Blockchain technology, with its decentralized and secure ledger system, can provide a tamper-proof and transparent way of conducting elections and voting. In a blockchain-based voting system, votes are recorded as transactions on a decentralized ledger, making it nearly impossible for anyone to manipulate the results. The use of cryptographic algorithms and consensus mechanisms further enhances the security and accuracy of the voting process. Blockchain technology has the potential to revolutionize the way voting systems are designed and implemented.

According to a report by Allied Market Research, the global blockchain voting market size was valued at $181.5 million in 2019 and is expected to reach $1,866.9 million by 2027, growing at a CAGR of 38.4% from 2020 to 2027.

This statistic indicates a significant potential for growth in the blockchain voting market in the coming years. The increasing demand for secure, transparent, and tamper-proof voting systems is one of the key factors driving the growth of the market. Blockchain technology is seen as a promising solution to address the challenges of traditional voting systems, such as fraud, manipulation, and low voter turnout.

The report also highlights that the adoption of blockchain-based voting systems is still in its early stages, and the market is highly fragmented with the presence of several small and large players. However, with the increasing interest and successful pilot projects, the market is expected to witness significant growth in the coming years.

1.2.2   Overview of the Existing Systems

Voting is an essential process in corporations, and the method used for voting can vary depending on different factors. For instance, the size and structure of the corporation, as well as legal requirements in the jurisdiction where it operates.

One common method of voting is in-person voting, where shareholders or members of the corporation attend an Annual General Meeting (AGM) in person and cast their votes. In-person voting is often conducted using paper ballots, which are then counted manually or by electronic voting machines.

Another method is proxy voting, where shareholders who cannot attend the meeting in person appoint a proxy to vote on their behalf. This can be done through various means, such as mail, email, or online, and the appointed proxy can be another shareholder, an attorney, or a representative of the corporation.

Remote voting is also an option in some cases, where shareholders can cast their votes from a distance by mail, email, or online. This method is often used for routine matters, such as electing directors or approving the annual budget.

Finally, hybrid voting, a combination of in-person and remote voting, allows shareholders to attend the meeting in person or participate remotely via video conferencing or other electronic means.

It is worth noting that the specific procedures for voting in corporations are typically outlined in the corporation's bylaws or articles of incorporation. Moreover, these procedures may be subject to legal requirements and regulations in the jurisdiction where the corporation operates.

1.2.3 Overview of the Proposed System

The proposed system will implement a blockchain-based voting system by leveraging the security and transparency features of blockchain technology to record and verify votes.

The corporation would set up a blockchain network with a specific set of rules and protocols for recording and verifying votes. The blockchain network is implemented on a secure online web portal. Shareholders or members of the corporation are given a unique identifier, called a personal access token, that allows them to cast their votes on the blockchain network.The online web portal is only accessible to authorized personnel that have logged in with their personal access tokens.

When a shareholder casts a vote, the vote is recorded on the blockchain as a transaction that is validated by a network of nodes or computers running the blockchain software. The vote is then added to a block of transactions that is cryptographically linked to the previous block, creating a chain of blocks that cannot be altered or tampered with.

Once all the votes have been recorded, the blockchain network can tally the results and verify that they are accurate based on the rules and protocols set up by the corporation. The results can then be made available to shareholders or members of the corporation, providing a transparent and auditable record of the voting process. The results of the votes would be available to download and print for the sake of record keeping.

Blockchain-based voting systems in corporations offer several advantages, including increased security, transparency, and efficiency compared to traditional voting systems.

1.3   Problem Statement:

"Evaluating the effectiveness of blockchain-based voting systems in enhancing shareholder participation and reducing voting fraud in corporate elections." This research problem aims to investigate the potential of blockchain technology in addressing issues such as low voter turnout and voting fraud in corporate elections.

The research involves a comparative study of traditional voting systems and blockchain-based voting systems, examining factors such as voter turnout, the accuracy of vote counting, and the level of transparency and security in the voting process. The findings of this research could inform the decision-making of corporations considering the implementation of blockchain-based voting systems and contribute to the broader understanding of the potential benefits and limitations of blockchain technology in corporate governance.

1.4   Objectives:

1.4.1   Project Goal (Major Objective) Overall Goal:

The system aims to improve the integrity and efficiency of corporate voting processes and promote trust and accountability among stakeholders. It also investigates the current challenges and limitations of the traditional voting systems used in corporations and explores potential benefits of using a blockchain-based voting system. It also evaluates feasibility of implementing a blockchain-based voting system for corporations, including the technical, legal, and ethical considerations.

1.4.2   Specific Objectives:

1. To develop a web-based blockchain application where stakeholders can log in and vote for their respective publicly listed companies.
2. To compare the blockchain-based voting system's performance and efficiency with the traditional system in terms of various factors such as security, transparency, time, cost, accuracy, and voter satisfaction.

3. To create a personal access token that enables identification of stakeholders who are voting.

4. To design a real-time vote counting and display system using smart contracts.

5. The system will allow stakeholders to view their voting history, and the results will be printable for record-keeping purposes.

1.5 Justification:

The system will provide the following benefits to the users of the system:

1. Improved Corporate Governance: The use of blockchain technology in corporate voting can increase the transparency, accountability, and integrity of the decision-making process. This can improve corporate governance, reduce the potential for fraud and conflicts of interest, and enhance the trust and confidence of stakeholders.

2. Enhanced Security: Blockchain-based voting systems can provide stronger security features compared to traditional voting systems. Blockchain technology provides tamper-proof and immutable records, making it almost impossible to manipulate or alter the voting results, which can reduce the risk of fraud or cyber attacks.

3. Improved Efficiency: A blockchain-based voting system can reduce the time and cost associated with traditional voting systems. It can eliminate the need for intermediaries, paper-based documentation, and manual vote counting, reducing the administrative burden on the organization.

4. Alignment with Technology Trends: As blockchain technology gains wider adoption in various industries and sectors, it is increasingly becoming a standard for secure and transparent data management. Corporations that adopt blockchain-based voting systems will be aligning themselves with this technological trend and positioning themselves for future growth and innovation.

5. Improved Stakeholder Satisfaction: A transparent and secure voting system that enables stakeholder participation in the decision-making process can increase the satisfaction of stakeholders, including shareholders, investors, and employees. This can lead to increased loyalty, trust, and engagement in the organization.

1.6   Scope of the Study:

In scope:

A blockchain voting system could be a solution to traditional voting systems. This system could work as follows:

1. Shareholders would be issued digital tokens that represent their ownership in the corporation. These tokens would be stored on a blockchain platform.
2. When a vote is called for, shareholders would be notified via a secure online portal and email. They would be able to review the information and issues to be voted on, and cast their vote using their digital tokens in the online portal.
3. The votes would be recorded on the blockchain platform in a tamper-proof manner, ensuring the integrity of the voting process.
4. The vote counting process will be automated using smart contract technology, eliminating the need for manual counting.
5. The results of the vote would be made available to all shareholders in real-time on the online web platform, increasing transparency and trust in the voting process.
6. The system would include a secure way of identification of the shareholders and also a way of auditing the process, also to make sure that the right person is voting.
7. The system would also include a way of tracking the voting history of the shareholder, to make sure that they can't vote more than once or vote in different ways.
8. The system would also include a way for shareholders to download and print the voting results for record keeping.

Out of scope:

1. Shareholder engagement: While the system may improve the ease and convenience of voting for shareholders, it may not be responsible for driving engagement or participation in the voting process.
2. Non-voting matters: The system would only be designed to handle voting matters related to the corporation, such as electing directors or approving the annual budget. Other

matters, such as discussions or presentations, would not be within the scope of the system.

3. Technical issues outside the system: The system would be designed to ensure the efficiency and accuracy of the voting process, but it cannot account for technical issues that occur outside the system, such as internet connectivity issues or hardware malfunctions on a shareholder's device.

1.7   Limitations of the Proposed System:

Like any voting system, a blockchain-based voting system in corporations has several potential limitations and drawbacks that should be considered. Here are some limitations of the proposed system:

- Cost: Implementing and maintaining a blockchain-based voting system can be expensive, especially for small or medium-sized corporations. The cost of hardware, software, and personnel can make it impractical for some organizations.
- Scalability: The performance and scalability of a blockchain-based voting system may be limited, especially if many users are participating in the system simultaneously. This could lead to delays or other technical issues.
- Legal and regulatory challenges: Blockchain-based voting systems may be subject to various legal and regulatory requirements, which can be complex and vary by jurisdiction. Ensuring compliance with all relevant laws and regulations can be challenging.

1.8   Project Risk and Mitigation:

- Technical challenges: Developing and implementing a blockchain-based voting system requires a high level of technical expertise. This is solved by extensive study and consulting with those that are experienced in the field.
- Resistance to change: Introducing a new voting system may face resistance from shareholders who are accustomed to traditional voting methods. This is solved by

conducting an extensive communication and education campaigns to inform stakeholders about the benefits of the new system and address their concerns.

- Laptop devices might crush or infected with a computer virus. This is solved by implementing multiple nodes or computers that can be used to validate and store the blockchain data, ensuring that the system can continue to function even if one node or computer is compromised.
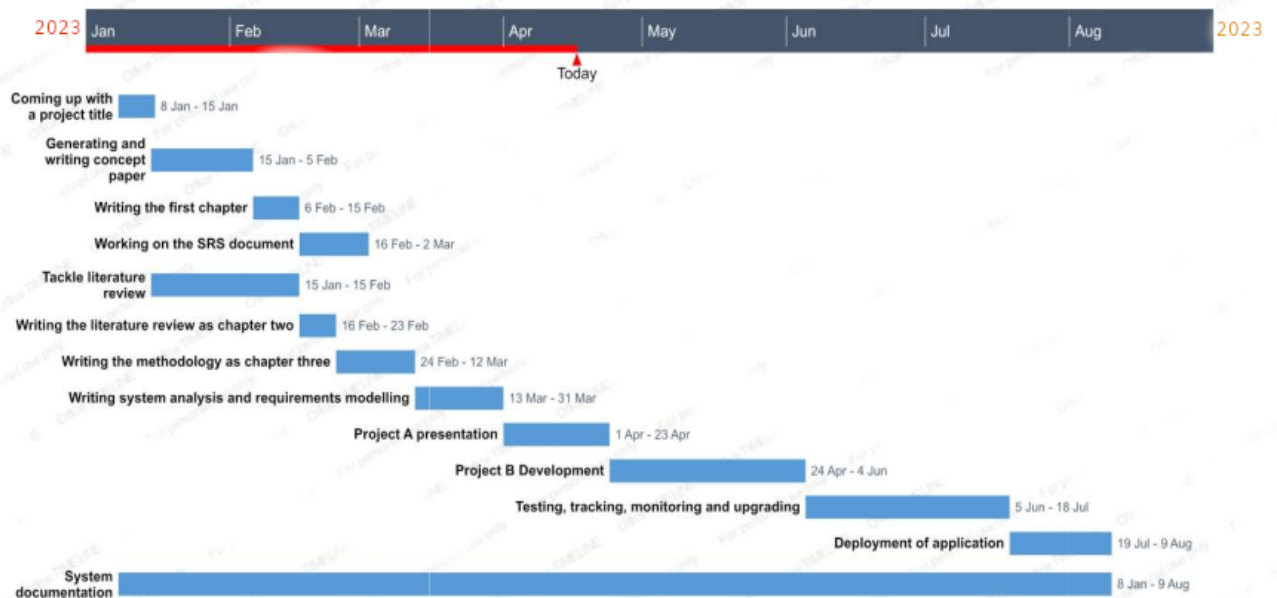
1.9   Project Schedule:

Figure 1: Project Schedule

1.10 Budget and Resources:

RESOURCES	DESCRIPTION	SPECIFICATIONS	UNITS	PRICE
Laptop	For doing the project, coding the web based application	Minimum requirement of Core i5, RAM 8 GB and storage space of 500 HDD	1	Ksh 40,000 (Available)
Mobile phone	To do testing	Smartphone	1	Ksh 20000
Internet access	To facilitate access to online features	At least 30mbps	-	Ksh 4500 per month
Cloud Storage Backup	To back up progress in case of crash failure	At least 20 GB	-	Ksh 3000
Miscellaneous	Typing, printing cost throughout the project	-	-	Ksh 5,000
				Total = 72, 500

Table 1.1 Budget and Resources

CHAPTER TWO: LITERATURE REVIEW

As of the year 2023, the Nairobi Securities Exchange (NSE) boasts a total of 62 publicly listed companies, which are categorized into 13 distinct sectors, according to the data sourced from the NSE website. Each of these companies conducts an Annual General Meeting (AGM) where the senior leadership meets with shareholders to deliberate on the company's performance. In this section, we will delve into the various voting systems utilized during the AGMs and provide actionable solutions to mitigate errors and improve the effectiveness of the system.

2.1 Reviewed Similar Systems

2.1.1 Unstructured Supplementary Service Data (USSD) Code Voting.

The company Act 2015, was amended to permit companies to convene and conduct a virtual general meeting. USSD voting is a type of mobile voting system that allows shareholders to cast their votes on resolutions or proposals using their mobile phones via a USSD code. In Kenya, the USSD code for voting is *483*code#, where "code" represents a unique voting code provided by the company. This system is becoming increasingly popular in the NSE as it provides a convenient and cost-effective way for shareholders to participate in company decisions remotely. Companies voting using USSD include Safaricom PLC, NSE PLC, Diamond Trust Bank and Standard Group.

Shareholders wishing to participate in the meeting, register for the AGM by dialing the USSD code for all networks and following the various prompts regarding the registration process. They should have the ID/Passport they used to buy the shares and/or the CDSC Account number. The registration period comes prior to the AGM on a specified timeframe. Registered shareholders can ask questions via the USSD code by selecting the option ask questions.

USSD voting is typically used during Annual General Meetings (AGMs) and Extraordinary General Meetings (EGMs) where shareholders are required to vote on various issues such as the election of directors, appointment of auditors, approval of financial statements, and any other matters that may require shareholder approval.

The AGM is streamed live via a link which is provided to all registered shareholders. They can then vote(When prompted by the chairman) via the USSD prompts. Once the vote has been cast, the shareholder receives a confirmation message indicating that their vote has been recorded.

USSD voting is beneficial to both shareholders and companies. For shareholders, it eliminates the need to physically attend meetings, which can be time-consuming and expensive, especially for those who live far away from the venue. It also provides a transparent and efficient voting process that ensures that their votes are accurately recorded and counted.

For companies, USSD voting increases shareholder participation and engagement, which is essential for good corporate governance. It also reduces the administrative burden associated with traditional paper-based voting systems, which can be cumbersome and prone to errors.

In conclusion, USSD voting is a valuable tool that can be used by publicly listed companies to improve shareholder participation and engagement. It provides a convenient and cost-effective way for shareholders to cast their votes remotely, while also promoting transparency and good corporate governance in the Kenyan market.

2.1.2 C & R Group

C & R Group is a Kenyan firm, founded in 2010, that specializes in providing end-to-end solutions for the efficient management of AGMs for companies listed on the NSE. The firm offers a comprehensive range of services that aid in the voting process during AGMs, ensuring that shareholders can conveniently and easily participate in company decisions.Such companies include Kakuzi PLC, Sameer Africa, Kenya Airways and NCBA Bank.

One of the ways that C & R Group aids voting in AGMs is by providing a secure and user-friendly online voting platform. The platform allows shareholders to cast their votes remotely, from anywhere in the world, using a computer or mobile device. The system ensures that votes are accurately recorded and counted, and provides real-time updates on the voting process.

Additionally, C & R Group offers a USSD voting system, which is a type of mobile voting system that allows shareholders to cast their votes on resolutions or proposals using their mobile phones via a USSD code provided by the company. This system provides a convenient and cost-effective way for shareholders to participate in company decisions remotely, especially for those who may not have access to the internet or a computer.

They provide comprehensive support services to companies during the AGM process. This includes managing the registration of shareholders, verifying their identities, and ensuring that they are provided with all necessary information and documentation. The firm also provides technical support and troubleshooting during the voting process, ensuring that any issues or errors are resolved in a timely manner.

In addition to electronic voting, C & R Group also provides other value-added services, such as pre-AGM registration, live streaming of the AGM, and data management. These services aid in the organization and management of AGMs, ensuring that the process is seamless and efficient.

Overall, C & R Group's services aid voting in AGMs for companies in the NSE by providing convenient, efficient, and secure methods for shareholders to participate in company decisions. The firm's solutions ensure that the AGM process is well-managed and that all shareholders are provided with equal opportunities to vote and have their voices heard.

2.1.3 Computershare Virtual Meeting Services

Computershare Limited is an Australian stock transfer company, founded in 1978, that provides corporate trust, stock transfer, investor services for shareholders and employee share plan services in many countries. It has found its way to Kenya through ABSA Group Limited which is a South African-based financial services group, offering personal and business banking, credit cards, corporate and investment banking, wealth and investment management, as well as bank assurance.

Computershare's virtual meeting services provide publicly listed companies with a comprehensive solution for conducting Annual General Meetings (AGMs) and other important company meetings remotely. With this service, shareholders can participate in meetings from anywhere with an internet connection, without the need to attend in person.

One of the most significant benefits of Computershare's virtual meeting services is the advanced voting capabilities that allow shareholders to cast their votes on resolutions and proposals before or during the meeting. This feature ensures that all votes are accurately recorded and counted, promoting transparency and good corporate governance.

The virtual meeting platform also includes interactive features such as chat, polling, and Q&A sessions, which enable shareholders to engage with management and ask questions during the meeting. This can help to foster shareholder participation and engagement, which is essential for good corporate governance.

Computershare's virtual meeting services are designed to be user-friendly and secure, with professional support from experienced meeting coordinators who ensure that the meeting runs smoothly and efficiently. The platform also includes recording and archival capabilities, which enable companies to record and archive virtual meetings for future reference.

Overall, Computershare's virtual meeting services provide publicly listed companies with a convenient and cost-effective way to hold meetings remotely, while also promoting transparency, shareholder participation, and good corporate governance.

2.2 Tools and Methodologies Used in the Reviewed Systems

2.2.1 Unstructured Supplementary Service Data (USSD) Code Voting.
This program uses USSD codes: This is the primary tool used in USSD voting. It is a code that is dialed by shareholders on their mobile phones to access the voting system. The USSD Code used

by companies in Kenya is *483*code# where "code" represents a unique voting code provided by the company, e.g, 801 for KCB Group, 809 for Nation Media Group and 560 for NSE PLC.

The voting system is delivered through mobile networks, such as Safaricom and Telkom, which must be reliable and secure to ensure that the voting process is efficient and accurate. Shareholders may also receive SMS notifications with information on how to access the voting system and reminders to participate in the voting process.

Robust backend systems are required to manage the voting process and ensure that all votes are accurately recorded and counted. USSD voting systems must also have strong security protocols in place to protect against fraud and unauthorized access. Data analytics is an important component of USSD voting systems, as they generate data that can be analyzed to gain insights into shareholder participation and engagement. This data can be used to improve future voting processes and promote good corporate governance.

In summary, USSD voting systems rely on a combination of technology and methodology to ensure that the voting process is convenient, efficient, and transparent for shareholders. By leveraging these tools and methodologies, publicly listed companies can improve shareholder participation and engagement while promoting good corporate governance.

Pros
- Convenience: USSD voting systems provide a convenient way for shareholders to participate in voting processes without having to physically attend meetings. Shareholders can cast their votes from anywhere at any time using their mobile phones, which saves them time and money.
- Increased participation: USSD voting systems increase shareholder participation in voting processes by making it easier for them to cast their votes. This promotes good corporate governance by ensuring that all voices are heard and that decisions are made in the best interest of the company.

Cons

- Limited functionality: USSD voting systems have limited functionality compared to other voting systems. They are primarily designed for simple yes/no or multiple-choice questions, which may not be sufficient for more complex voting scenarios.
- Lack of security: While USSD voting systems have security features such as one-time passwords and encryption, they may still be vulnerable to hacking or other types of cyber attacks. This could compromise the integrity of the voting process and potentially impact the outcome of the vote
- Cost: While USSD voting systems are generally more cost-effective than traditional voting systems, they still require some investment in terms of infrastructure and maintenance. This could be a barrier to entry for some companies, particularly smaller ones.
- Network connectivity issues: USSD voting requires a stable and reliable network connection. If there are connectivity issues or network outages, shareholders may not be able to participate in the voting process, leading to potential disenfranchisement.

2.1.2 C & R Group

The C&R Group provides an electronic voting platform that allows shareholders to vote remotely using their mobile phones, computers or other devices that provides an efficient way for shareholders to participate in the voting process. It assists companies in soliciting proxies from their shareholders by encouraging shareholders to vote by proxy.

C&R Group also helps companies to communicate effectively with their shareholders. This includes sending out notices of the AGM, providing information on the voting process, and answering any questions shareholders may have.

Pros

- Provides comprehensive AGM management services
- Offers customized solutions to meet specific client needs
- Provides a range of electronic voting platforms, including USSD, SMS, and online voting
- Enhances shareholder engagement and participation in AGMs

<u>Cons</u>
- Increased costs for companies
- Potential technical difficulties or malfunctions during the voting process
- Limitations in accessibility for shareholders who may not have access to mobile devices or internet services
- Security Issues. The system may be vulnerable to hacking or other types of cyber attacks which could compromise the integrity of the voting process and potentially impact the outcome of the vote.

2.1.3 Computershare Virtual Meeting Services

Computershare Virtual Meeting Services uses a range of tools and methodologies to ensure that shareholders can participate in meetings remotely. One of the primary tools used is the webcasting platform, which allows shareholders to watch the meeting live from their computer or mobile device. The platform is designed to provide high-quality video and audio streaming, as well as interactive features that allow shareholders to ask questions and participate in discussions in real-time.

Another important tool used by Computershare Virtual Meeting Services is the online voting system. This system enables shareholders to cast their votes remotely through a secure online portal. The system is designed to be user-friendly, with a simple interface that allows shareholders to easily navigate through the voting options and cast their votes on various proposals or resolutions.

<u>Pros</u>
- Computershare Virtual Meeting Services allows for real-time communication between shareholders and the company's management, providing an avenue for shareholders to ask questions and provide feedback during the meeting.
- It provides a cost-effective solution to traditional AGM voting methods, which require shareholders to physically attend the meeting venue.

Cons
- Technical issues: The system relies heavily on internet connectivity and may experience technical glitches such as poor video quality, delayed audio, or even disconnections which can affect the voting process.
- Security concerns: Virtual meetings may be susceptible to cyber attacks or hacking attempts, which could compromise the integrity of the voting process and affect the outcome of the AGM.

2.3 Gaps in the Existing Systems

USSD voting is a convenient and cost-effective way for shareholders to cast their votes on company decisions. However, the system is not entirely secure, as it can be vulnerable to hacking, and there is a risk of vote manipulation. USSD voting is prone to errors due to network connectivity issues and may not be accessible to all shareholders who do not have a registered mobile phone. Additionally, USSD voting does not provide a completely transparent voting process, as the data can be easily altered and is not easily auditable.

One problem with the C&R Group is transparency, it relies on manual vote counting and result tabulation, which can be prone to errors or tampering. This process can be time-consuming, which may delay the announcement of the results, and there may be limited visibility into the vote counting process. In addition, there is a risk of voter impersonation, which could undermine the integrity of the voting process.

It may also not provide real-time access to vote tallies and results to all shareholders. This could lead to questions about the accuracy and fairness of the voting process, particularly if there is a delay in the announcement of the results. In some cases, there may be limited information provided to shareholders about how their votes were counted or how the results were reached.

Overall, while the C&R Group provides a comprehensive range of services to support shareholder voting, there are potential transparency issues that could be addressed with the implementation of more advanced technology such as blockchain-based secure and transparent voting systems.

Auditing the voting results is also a challenge. While Computershare does provide some auditing services, it can be difficult to conduct a comprehensive audit of the voting results due to the large volume of votes cast and the complexity of the voting process. This can make it difficult to identify and address any errors or issues that may arise, which could impact the outcome of the vote.

2.4 The Proposed Solution

The proposed solution to the above challenges include:

1. Implementing the system using blockchain technology: The new system will leverage blockchain technology to ensure transparency, security, and immutability of the voting process.
2. Use of smart contracts: The use of smart contracts will ensure that the voting process is automated and tamper-proof.
3. Use of digital identity verification: To prevent fraudulent activities and ensure that only eligible voters participate in the process, the new system will employ digital identity verification techniques such as biometric authentication or two-factor authentication.
4. Real-time voting results: The system will provide real-time voting results that are publicly accessible, ensuring transparency and accountability.
5. Immutable audit trail: The blockchain technology employed in the system will create an immutable audit trail that can be used to verify the accuracy of the voting process.
6. Decentralized system: The new system will be decentralized, meaning that it will not be controlled by any central authority. This will ensure that the voting process is not influenced by any external factors.
7. Accessibility: The system will be accessible to all eligible voters, regardless of their location, using any internet-enabled device.
8. Ease of use: The new system will be user-friendly and easy to navigate, ensuring that even non-technical users can participate in the voting process without any difficulties.
9. Scalability: The system will be designed to handle a large number of voters and votes, ensuring that it can be used for both small and large-scale voting processes.

CHAPTER THREE: METHODOLOGY

3.1 Methodology and tools

Methodology refers to the overall approach or framework used to plan, execute, and manage a research project. It includes the processes, procedures, and techniques used to achieve the research objectives. Methodologies provide a structured approach to research and typically include phases, such as problem identification, literature review, research design, data collection, data analysis, and conclusions.

This chapter will focus on the methodology I will use in my project and the various tools I intend to use to analyze data.

3.1.1 Methodology

For this project, Agile Methodology will be used. It is an iterative and flexible approach that emphasizes continuous improvements.
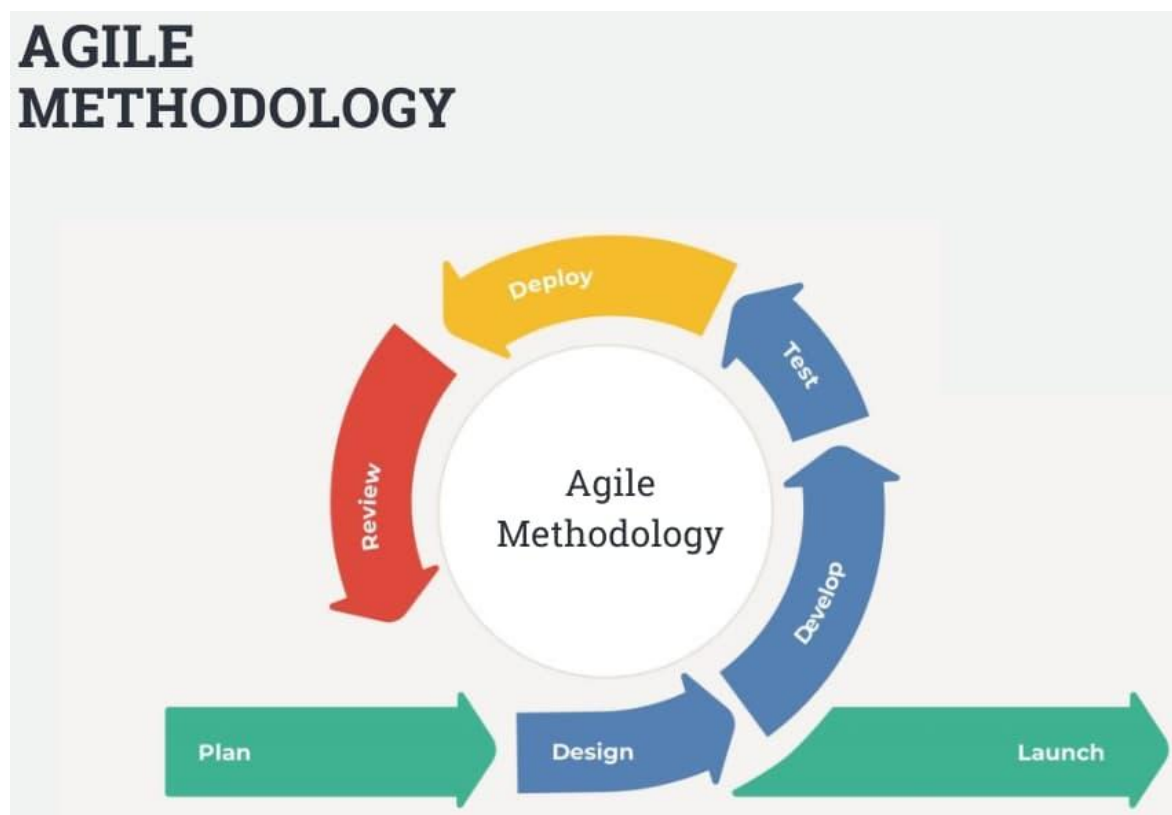

Figure 2: Agile Methodology

The methodology consists of the following phases:

1. Plan

   This is the initial Phase that sets the foundation of the entire project. The project objectives, scope and requirements are defined and the project roadmap is created. Requirements are analyzed to determine the feasibility of the project.

2. Design

   This phase involves designing and prototyping the product. A functional design that meets users needs is created. This phase is an iterative phase where there is continuous improvement and design based on feedback and testing.

3. Develop

   This phase involves actually developing the product in sprints focusing on developing a working increment of the software product. There is testing with a focus on catching and fixing any issues early in the development process.

4. Deploy

   This involves deploying the product to production or releasing it to end-users. The Deploy phase is the final stage in the development process and involves testing the product in a live environment.

5. Review

   Review involves reviewing and evaluating the product's performance and the development process. It occurs at the end of each sprint and includes both a retrospective and a demo. The Review phase is an essential component of the Agile methodology, as it allows continuous improvement of the product and the development process.

6. Launch

The Launch phase involves releasing the product to the market or to end-users. It includes ongoing monitoring and maintenance to ensure that the product remains up-to-date and meets the user's needs.

Reasons for using agile methodology:

- Flexibility: Agile methodology is designed to be flexible and adaptable to changing circumstances. In a research project, this can be particularly important, as the project may involve uncertainty or unexpected findings.
- Iterative approach: Agile methodology involves an iterative approach, with regular review and feedback sessions which can be valuable, as it allows refinement and improvement of the research as I go. By regularly reviewing the project and receiving feedback, I can identify areas for improvement and make adjustments accordingly.
- Focus on delivering value: Agile methodology focuses on delivering value to the end-user.This ensures that the research is designed to address the respective needs and priorities. By focusing on delivering value, I can ensure that the research is relevant, practical, and useful.

3.1.2 Tools to be used in the methodology

This methodology will be able to utilize a number of tools to show the conceptual and logical flow of the processes in the application.

a. Flowcharts

It will use symbols and diagrams to illustrate the steps in a process and the relationships between them, providing a clear and concise way to understand how a system works. Flowcharts will be used to analyze and optimize processes, identify bottlenecks and inefficiencies, and communicate complex information in a simple and easy-to-understand format.

b. Use Case Diagrams

It will be used as a visual representation of the interactions between actors (users or systems) and the system. It will be used to provide a high-level overview of the system's

functionality and to identify the different types of users or stakeholders involved. This can help to identify potential errors or inefficiencies in the system, as well as opportunities for improvement.

   c.   Data Flow Diagrams

A Data Flow Diagram (DFD) will be used as a tool to represent the flow of data within a system or process. It will provide a visual representation of how data is input, processed, and output from the system, highlighting any potential bottlenecks or inefficiencies. The DFD will be a valuable tool for identifying areas for optimization and improving the overall efficiency and effectiveness of the system.

3.2 Source of Data

In order to accomplish the task at hand, it is vital to collect data from different sources both primary and secondary data.

Primary Data

A primary source of data is original information collected directly from the source. It can include surveys, interviews, experiments, observations, or other firsthand accounts of events or phenomena.

Secondary Data

A secondary source of data is information that has been collected and analyzed by someone else. It includes published works, such as books, journals, and reports, as well as data from online sources and databases.

3.3 Data Collection Methods

To ensure that the data collected will be accurate and relevant, I will use the following methods for data collection:

   a.   Questionnaires

It will entail me designing a set of questions to be administered to a group of respondents in order to collect data. This method of data collection is commonly used in surveys and

can provide valuable information on attitudes, beliefs, and behaviors. By carefully constructing the questionnaire and selecting a representative sample of respondents, I can obtain accurate and reliable data that can help inform research or decision-making processes.

b. Observation

It will entail me observing and recording events or behaviors as they occur in a natural or controlled environment. This method of data collection can provide valuable insights into human behavior, social interactions, and the environment. By carefully documenting observations, I can identify patterns, behaviors, and other relevant information that can help inform research or decision-making processes.

c. Interviews

It will entail me conducting face-to-face or virtual conversations with individuals or groups to collect data. This method of data collection can provide in-depth information on attitudes, beliefs, experiences, and opinions.

d. Literature Review

It will entail me reviewing published literature, such as books, journals, and reports, to collect data. This method of data collection can provide valuable insights into the current state of research on a particular topic, identify gaps in knowledge, and inform future research directions. By carefully selecting and analyzing relevant literature, I can obtain a comprehensive understanding of the research topic and use it to inform research or decision-making processes.

3.4 Resources required / materials

Hardware Specifications

- Laptop - Used as the working platform for this project
- Processor speed – Intel (R) Core i5 ,2.60GHz
- Memory requirements – Minimum of 4 GB RAM.
- Hard disk capacity – Minimum of 500 GB.

<u>Software Specifications</u>

- VSCodium - VSCodium is a free and open-source code editor that is based on the Visual Studio Code (VS Code) editor by Microsoft. It is designed for developers who prefer a fully open-source development environment.
- Frontend development tools - I will use ReactJS to develop my front end.
- Backend development tools - They will include, NodeJs(provides the runtime environment for executing JavaScript code on the server-side), Express(provides the runtime environment for executing JavaScript code on the server-side) , MongoDB (provides a flexible and scalable database for storing and retrieving data), Mongoose and MongoDB object modeling tool.
- Remix IDE - To write smart contracts that would implement the blockchain technology.
- Software configuration management tools – Include github and bitbucket to track changes in the software.
- Operating System - ParrotOS

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