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Cost-Effective Biometric Handprint Voting System

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I | Abstract

Ever since the COVID-19 pandemic took the world by storm back in December 2019, it brought along with it a global wave of economic distress causing many countries worldwide to prioritize survival more than most, by any means necessary, whether it be raising taxes or borrowing from others to make up for the many losses suffered during this period of instability. However, the issue with this form of temporary short-term stability is that countries with already struggling economies only fail to see the decades of debt lying in wait for their future.

This brings us to the current situation Sri Lanka has been in and currently is in at present; ensnared in a debt trap (Moramudali, 2017). As of today, Sri Lanka owes about US $7 billion to China and around US $1 billion to India (Perera, 2022). Having already borrowed billions worth of foreign currency from many other countries as well, the unexpected pandemic only further worsened the situation for the country. As a result the government has had to resort to giving China a controlling equity stake and a 99-year lease for Hambantota port (Hillman, 2018), whilst the Western Terminal has been handed over to an Indian company (Farzan, 2021); all for the sake of maintaining its relationships with these countries and extending debt deadlines to stay afloat; given that its damaged reputation with other lenders following its failure to make an interest payment on its foreign debt for the first time, made it even harder to borrow money on the international markets (Perera, 2022). As Moramudali (2017) said it best “Sri Lanka, in fact, had no option but to reach out for money and was in no position to refuse these offers which ultimately had placed the Sri Lankan government between a rock and a hard place.”

After careful assessment of the country's state of emergency and past expenditures that may have majorly contributed to this current situation, a statistic that was quite hard to overlook has been the election costs; with at least LK Rs.7 billion spent for the last parliamentary elections in 2020 and the upcoming elections estimated to cost a minimum of LK Rs.10 billion (Bandara, 2022). Additionally, according to Jayasinghe (2020) it has been stated that the money spent per voter by a party or an individual candidate has increased from LK Rs.67 to about LK Rs.600; almost ten times as much as it used to be back in 2004. The issue with this increment is that the election process on its own has undergone little to no noticeable changes whatsoever despite the higher costs and increased budget allocations. A driving factor behind this surge in expenditure could be the exploitation of the fact that Sri Lanka still lacks a campaign finance law, therefore the political parties are not legally bound to present a financial statement on poll related expenditures to the Election Commission; explaining why parties fearlessly spend as they please to make sure they secure the win. It is further stated that the shared value of LK Rs.1.3 billion in campaign expenditures amongst the three main contenders of the 2019 elections were based on the minimum figures, so the actual expenditures would be much higher than those in the reports (Fernando, 2019).

Hence why not only a biometric voting system has been proposed but a cost-effective means of implementing it as well. The cost-effective method of implementation stems from the age-old proverb that "slow and steady wins the race". Moralizing the very principle that one is better off being methodical than rushing into something unprepared (Poem Analysis, n.d.), is one that fits perfectly with the current cards the country has been dealt - with little to no room for investing in projects with diminishing returns.

As for the system itself, it is set to replace one of the single handedly most costly and recently outdated traditions the country still follows up to this day; the paper-based elections. The reason being as Sherlan Benedict said it best is because “A vote is precious. It is the most powerful non-violent tool that we have in a democratic society to express our intentions” (Newsfirst Sri Lanka, 2021), therefore leaving it as exposed as it is, to fraud and various other forms of tampering is a much greater danger than mere negligence. Which is why the discussed biometric voting system is key as it puts the safety of the peoples’ votes in their own hands. This consensual, non-intrusive form of voting optimizes the use of handprints as a means of identification, verification and confirmation of the voter’s identity and choice. Moreover, the system is paper-free and therefore entirely negating the cost of printing ballot papers saving the country an estimated full cost of about LK Rs.2 billion worth in printing expenses alone (NDTV). The system is further uniquely designed to be able to match a fingerprint to the owner of a handprint stored in its database, regardless of the fingerprint input being altered; swiftly identifying the owner of the input fingerprint and therefore nullifying the need for the unnecessary and constant re-registration process that is usually the case with these types of systems. By incorporating this technology, the voting process can be made more secure, accurate, and efficient whilst making it more accessible and transparent, promoting greater democratic participation and contributing to the overall improvement of the democratic process.

The research was done with the purpose of seeking an understanding on how handprints and fingerprints could be used in voting systems to effectively and efficiently register and identify individuals using their biometrics. Secondly, a look at how getting an understanding of this would help propose a cost-effective implementation of this new system over the traditional voting systems used was thoroughly taken. The current traditional voting methods are criticized for their high costs, lack of transparency and vulnerability to fraud. By incorporating biometric technology, the voting process can be made more secure, accurate, and efficient. The use of handprints will provide a unique, non-intrusive, and reliable way to confirm voters' identities while reducing costs. The end goal is to make the voting process more accessible, promoting greater democratic participation and contributing to the overall improvement of the democratic process.

1.1 Research Objectives

The research will seek to understand how handprints and fingerprints could be used in voting systems to effectively and efficiently register and identify individuals using their biometrics whilst keeping costs to a bare minimum. For this specific study to get a better understanding of what is needed to be accomplished in order to fulfill the purpose of the study; objectives have been set, to be used as guidelines right throughout the study and are as follows:

1. To assess the impact of biometric voting systems on the accuracy and reliability of election results.

2. To identify and evaluate the privacy and security risks associated with biometric voting systems, and develop recommendations for mitigation.

3. To conduct a cost-benefit analysis of biometric voting systems and traditional voting methods, and identify ways to reduce costs.

4. To study the social and political implications of biometric voting systems, and understand how they impact voter behavior and public trust in the election process.

1.2 Research Questions

Now that a better understanding of the research objectives have been established, these objectives have been converted to questions in order to guide the direction of analysis and ensure that a balanced perspective on the topic has been gained. The research questions are as follows:

1. How does the implementation of biometric voting systems impact the accuracy and reliability of election results?

2. What are the privacy and security concerns associated with biometric voting systems, and how can they be addressed?

3. What is the cost-effectiveness of biometric voting systems compared to traditional voting methods, and what factors contribute to these costs?

4. How does the use of biometric voting systems impact voter behavior, such as voter turnout and public trust in the election process?

1.3 Study Significance and Limitations

When it comes to projects it is essential to identify the significance of the study and also identify the limitations of the study. The significance of this study lies in its potential to revolutionize the field of voting systems by incorporating handprints and fingerprints as biometric identifiers, apart from this there is also:

1. Strengthening Result Credibility and Security - Enhancing election security by analyzing how biometric voting methods affect precision and dependability.

2. Risk Assessment and Mitigation - Addressing potential hazards by assessing them, coming up with mitigation solutions, and addressing privacy and security issues.

3. Analyzing Cost Effectiveness - Finding strategies to reduce costs and comparing cost-effectiveness to conventional voting techniques.

4. Analyzing Social and Political Implications - Studying the effects of such systems on voter behavior and public trust, and understanding the social and political ramifications.

5. Advancing with Tech - expanding our understanding of biometric voting systems and how they affect elections.

Now that an understanding of the study's significance has been addressed a dive into the ethical considerations and limitations of the study is in order. Firstly, the research is specific to handprint and fingerprint biometrics only and as a result may not be generally applicable to other systems optimizing different biometric traits such as facial features, iris patterns or vocal characteristics. Moreover, the study is entirely based on the usage of said system in the context of electoral processes hence the requirements of the system may vary in comparison to the usage of the same system in other contexts. It is also important to note that self-reported data may introduce the possibility of bias or errors, and other external factors that may have been likely to have influenced voter responses during the pandemic aftermath, which may not be fully controlled for. Therefore, conducting research during this period presented several challenges in accessing data and engaging participants.

It is important to note that the limitations outlined in this research topic should not be viewed as weaknesses, but rather as an inherent aspect of the research process. These limitations can provide valuable insights into potential areas for further study and exploration.

2 | Project Breakdown

2.1 Problem Identification

The current traditional voting processes have drawn criticism due to a number of significant problems, including expensive costs, a lack of transparency, and vulnerability to fraud. Due to the numerous instances of vote fraud that have been reported, these restrictions have had significant negative effects on the electoral system as a whole. Moreover, corrupt leaders throughout different generations have exploited the inefficiencies of this traditional method to manipulate and sway entire elections in their favor, undermining the principles of democracy. However, the incorporation of biometric technology offers a potential solution to these pressing issues. By leveraging non-intrusive biometric identifiers such as fingerprints, the voting process can be significantly enhanced in terms of security, accuracy, and efficiency. Biometric technology ensures that each voter's identity is verified with precision, reducing the risk of fraudulent votes. Additionally, the transparency provided by biometric systems instills greater trust in the electoral process, thereby bolstering democracy and safeguarding against manipulation. Through the adoption of biometric technology, we can pave the way for a more reliable and democratic voting system that upholds the principles of fairness, integrity, and equal representation.

2.2 Project Variables Analysis

In order to effectively understand and evaluate how biometrics can be utilized effectively for voting and understand its effects in the project, both the independent and dependent variables of the study need to identified and understood which in this case would be the following:

Independent Variable

The independent variable of this study is the specific type of voting system used. In this project it is the voting system that is created and focused around the utilization of non-intrusive biometric identifiers such as fingerprints.

Dependent Variable

The dependent variable is ideally the accuracy and efficiency of the votes along with their relevant details of identification of the voters.

3 | Methodology Approach

Before delving into the chosen methodology, it is important to understand the fundamental concept of data. In brief, data is any information that is structured in a specific format. The process of data collection involves gathering, measuring, and analyzing accurate information from relevant sources to address research questions, evaluate outcomes, and predict trends and probabilities. Data can be separated into two categories: quantitative and qualitative. Qualitative research centers on understanding the meaning behind words, while quantitative research concentrates on numerical figures and statistics. By utilizing quantitative methods, researchers can conduct systematic measurements of variables and test hypotheses. On the other hand, qualitative methodologies allow for a deeper exploration of concepts and personal experiences. In order to efficiently and effectively collect data and formulate said data around the research topic, the researcher will have to list down and shortlist data collection methods along with it's cost and processes. When it comes to data collection there are two main types of data:

1. Primary Research

As the name implies, this is original, first-hand data collected by data researchers. This process is the initial information gathering step, performed before anyone carries out any further or related research. Primary data results are highly accurate provided the researcher collects the information. However, there's a downside, as firsthand research is potentially time-consuming and expensive. Ideal examples that fall under this method is interviews, project data gathering, the Delphi technique, focus groups & questionnaires.

2. Secondary Research

Secondary data is second-hand data collected by other parties and have already undergone statistical analysis. This data is either information that the researcher has tasked other people to collect or information the researcher has looked up. Simply put, it is second-hand information. Although it is easier and cheaper to obtain than primary information, secondary information raises concerns regarding accuracy and authenticity. Quantitative data makes up a majority of secondary data. Unlike primary data collection, there are no specific collection methods Instead, since the information has already been collected, the researcher consults various data sources. Ideal examples that fall under this method is retailer/distributor/dealer feedback, customer personal information (e.g., name, address, age, contact info), business journals, government records (e.g., census, tax records, social security info), trade/business magazines & the internet.

For this project the main focus was on securing primary data. The most efficient method for collecting this data would be to distribute online questionnaires to remote individuals at random, and conduct focus groups with individuals from across the country. This approach allows for a comprehensive understanding of the impact the system would have on the general public as well as provide insights into how well people would adapt to this transformation.

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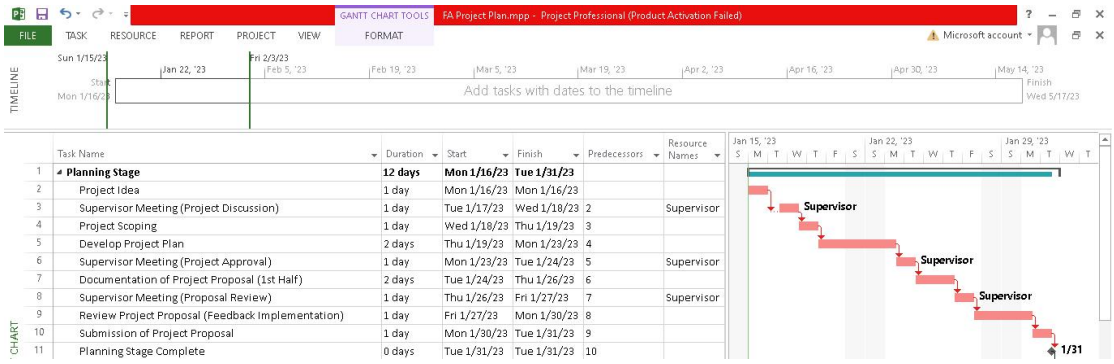
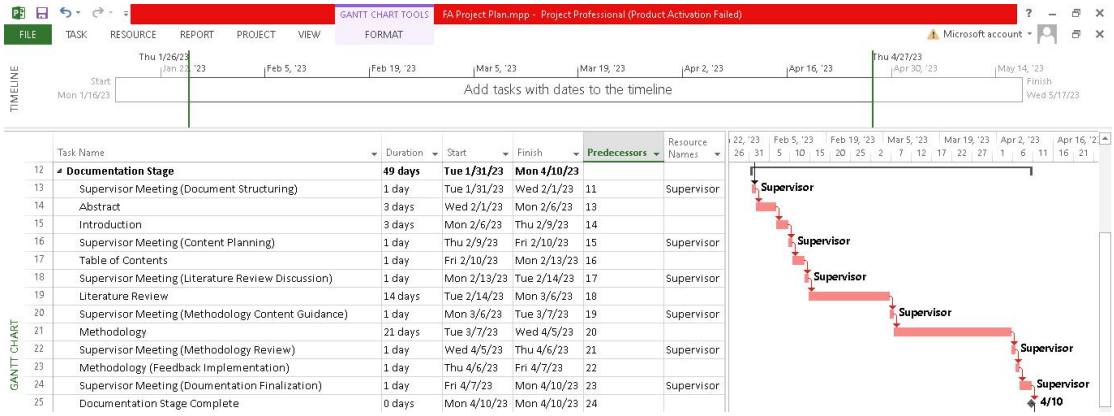
4 | Action Plan

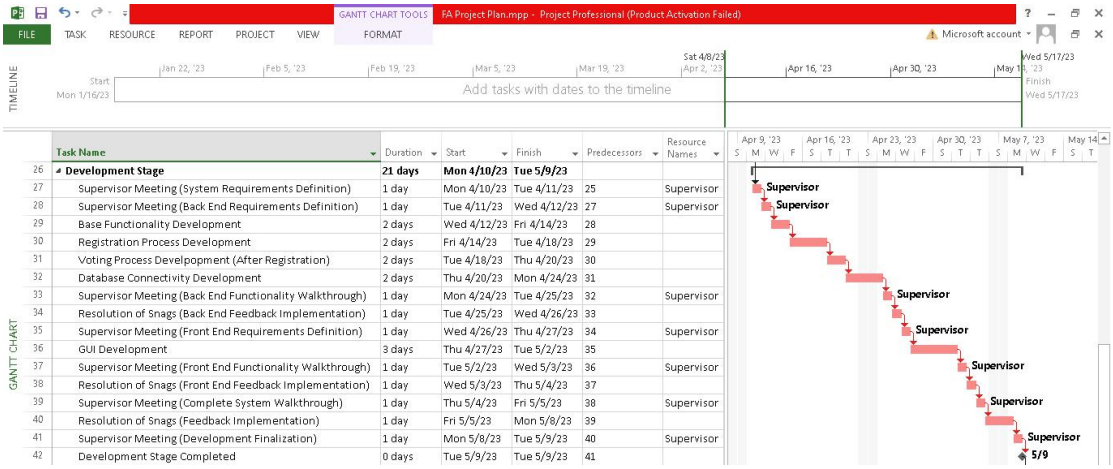
Expected Completion Timeframe



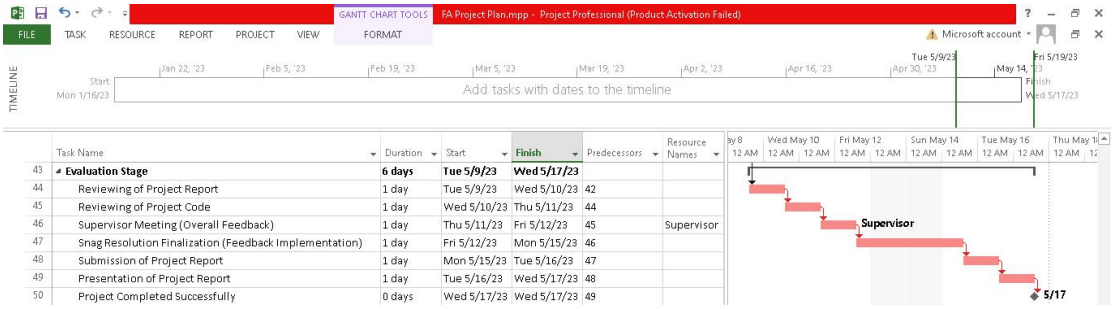
	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Planning Stage**	**12 days**	**Mon 1/16/23**	**Tue 1/31/23**		
2	Project Idea	1 day	Mon 1/16/23	Mon 1/16/23		
3	Supervisor Meeting (Project Discussion)	1 day	Tue 1/17/23	Wed 1/18/23	2	Supervisor
4	Project Scoping	1 day	Wed 1/18/23	Thu 1/19/23	3	
5	Develop Project Plan	2 days	Thu 1/19/23	Mon 1/23/23	4	
6	Supervisor Meeting (Project Approval)	1 day	Mon 1/23/23	Tue 1/24/23	5	Supervisor
7	Documentation of Project Proposal (1st Half)	2 days	Tue 1/24/23	Thu 1/26/23	6	
8	Supervisor Meeting (Proposal Review)	1 day	Thu 1/26/23	Fri 1/27/23	7	Supervisor
9	Review Project Proposal (Feedback Implementation)	1 day	Fri 1/27/23	Mon 1/30/23	8	
10	Submission of Project Proposal	1 day	Mon 1/30/23	Tue 1/31/23	9	
11	Planning Stage Complete	0 days	Tue 1/31/23	Tue 1/31/23	10	



	Task Name	Duration	Start	Finish	Predecessors	Resource Names
12	**Documentation Stage**	**49 days**	**Tue 1/31/23**	**Mon 4/10/23**		
13	Supervisor Meeting (Document Structuring)	1 day	Tue 1/31/23	Wed 2/1/23	11	Supervisor
14	Abstract	3 days	Wed 2/1/23	Mon 2/6/23	13	
15	Introduction	3 days	Mon 2/6/23	Thu 2/9/23	14	
16	Supervisor Meeting (Content Planning)	1 day	Thu 2/9/23	Fri 2/10/23	15	Supervisor
17	Table of Contents	1 day	Fri 2/10/23	Mon 2/13/23	16	
18	Supervisor Meeting (Literature Review Discussion)	1 day	Mon 2/13/23	Tue 2/14/23	17	Supervisor
19	Literature Review	14 days	Tue 2/14/23	Mon 3/6/23	18	
20	Supervisor Meeting (Methodology Content Guidance)	1 day	Mon 3/6/23	Tue 3/7/23	19	Supervisor
21	Methodology	21 days	Tue 3/7/23	Wed 4/5/23	20	
22	Supervisor Meeting (Methodology Review)	1 day	Wed 4/5/23	Thu 4/6/23	21	Supervisor
23	Methodology (Feedback Implementation)	1 day	Thu 4/6/23	Fri 4/7/23	22	
24	Supervisor Meeting (Doumentation Finalization)	1 day	Fri 4/7/23	Mon 4/10/23	23	Supervisor
25	Documentation Stage Complete	0 days	Mon 4/10/23	Mon 4/10/23	24	



	Task Name	Duration	Start	Finish	Predecessors	Resource Names
26	**Development Stage**	**21 days**	**Mon 4/10/23**	**Tue 5/9/23**		
27	Supervisor Meeting (System Requirements Definition)	1 day	Mon 4/10/23	Tue 4/11/23	25	Supervisor
28	Supervisor Meeting (Back End Requirements Definition)	1 day	Tue 4/11/23	Wed 4/12/23	27	Supervisor
29	Base Functionality Development	2 days	Wed 4/12/23	Fri 4/14/23	28	
30	Registration Process Development	2 days	Fri 4/14/23	Tue 4/18/23	29	
31	Voting Process Develpopment (After Registration)	2 days	Tue 4/18/23	Thu 4/20/23	30	
32	Database Connectivity Development	2 days	Thu 4/20/23	Mon 4/24/23	31	
33	Supervisor Meeting (Back End Functionality Walkthrough)	1 day	Mon 4/24/23	Tue 4/25/23	32	Supervisor
34	Resolution of Snags (Back End Feedback Implementation)	1 day	Tue 4/25/23	Wed 4/26/23	33	
35	Supervisor Meeting (Front End Requirements Definition)	1 day	Wed 4/26/23	Thu 4/27/23	34	Supervisor
36	GUI Development	3 days	Thu 4/27/23	Tue 5/2/23	35	
37	Supervisor Meeting (Front End Functionality Walkthrough)	1 day	Tue 5/2/23	Wed 5/3/23	36	Supervisor
38	Resolution of Snags (Front End Feedback Implementation)	1 day	Wed 5/3/23	Thu 5/4/23	37	
39	Supervisor Meeting (Complete System Walkthrough)	1 day	Thu 5/4/23	Fri 5/5/23	38	Supervisor
40	Resolution of Snags (Feedback Implementation)	1 day	Fri 5/5/23	Mon 5/8/23	39	
41	Supervisor Meeting (Development Finalization)	1 day	Mon 5/8/23	Tue 5/9/23	40	Supervisor
42	Development Stage Completed	0 days	Tue 5/9/23	Tue 5/9/23	41	



	Task Name	Duration	Start	Finish	Predecessors	Resource Names
43	**Evaluation Stage**	**6 days**	**Tue 5/9/23**	**Wed 5/17/23**		
44	Reviewing of Project Report	1 day	Tue 5/9/23	Wed 5/10/23	42	
45	Reviewing of Project Code	1 day	Wed 5/10/23	Thu 5/11/23	44	
46	Supervisor Meeting (Overall Feedback)	1 day	Thu 5/11/23	Fri 5/12/23	45	Supervisor
47	Snag Resolution Finalization (Feedback Implementation)	1 day	Fri 5/12/23	Mon 5/15/23	46	
48	Submission of Project Report	1 day	Mon 5/15/23	Tue 5/16/23	47	
49	Presentation of Project Report	1 day	Tue 5/16/23	Wed 5/17/23	48	
50	Project Completed Successfully	0 days	Wed 5/17/23	Wed 5/17/23	49	

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