Apply Analytic Hierarchy Process for Formulation and Prioritization of Trackability and Traceability Technology in Thailand's Election Supply Chain

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Abstract

Tracking and tracing in the supply chains can enhance supply chain visibility and productivity. This study will focus on Thailand's Election Supply Chain in tracking and tracing the ballot papers to improve the transparency and consistency of the process. By an intensive literature review, there is four technology which use in this field: Radio Frequency Identification (RFID), Internet of Things (IoT), Global Positioning System (GPS), and Blockchain. The six important of choosing technology factors which include transparency and accuracy, reliability, the cost of technology, real-time data, standardization, and security. The Analytic Hierarchy Process (AHP) is applied to evaluate those. As a result, transparency and accuracy are the most important factor in the expert's decision. In terms of technology shows that Radio Frequency Identification (RFID) technology has a high weight with 0.47 of the important point. While Global Positioning System (GPS), Internet of Things (IoT), and Blockchain have 0.23, 0.15, and 0.15 respectively.

Index Terms : Election, Thailand, AHP, Supply chain.

1. Introduction

Progressively more businesses are requiring the trackability and traceability of products and services in the supply chain while it is capable of enhancing supply chain productivity and detectable. A supply chain is the formation of many parties' involvement such as organizations, individuals, technology, activities, information, and other. Track and trace require the detection of objects, the recall of movement as the objects move across the supply chain, and the demand of movement for the definiteness of the objects. The previous study can indicate which part of Thailand will use ballot paper or electric voting machines (EVM). The result of the study showed that only the Bangkok area can use and the other provinces need to use the traditional ballot paper [1]. This study focuses on tracking and tracing Thailand's Election Supply Chain on the ballot paper. To discover the proper track and trace, first to understand the current Thailand Election Supply Chain then a literature review of technology solutions. The methodology analytic hierarchy is used to evaluate all the way

through relative assessments of factors creating decision-making. The result of this study is the technology to apply Thailand's Election Supply Chains.

2. Thailand Election Supply Chain

Transportation of ballot papers in Thailand can be divided into two phases: transportation from the ballot factory to each province and transportation from the province to the polling station. In the first part, the person in charge is the Thailand Post, whose truck will pick up the ballot from the designated factory. In front of the factory, ECT (Election Commission of Thailand) officials will be responsible for inspecting ballot papers. The ballot papers will be checked on the package number on the box before being loaded into the truck. The postal truck will be tracked all the time to prevent running off the route and can be inspected. After that, the postal truck will bring the ballot papers to be distributed at the operational center at the post office. At the place, no box will be opened to check the number of ballots of any kind. Vote-by-mail distribution of ballot papers will never be collected at the center. When the vehicle travels to pick up the ballot papers, a batch of vehicles is prepared to immediately distribute the ballot papers to designated areas. This transport will also include election equipment such as ballot boxes, booths, etc. While transporting, an officer will accompany the transport, namely two postal officers, and the process of carrying the ballot on a 6-wheel truck that has been installed with a Global Positioning System or (GPS).

The next phase is one day before the election. The ECT will take over from Thailand Post after the ballot papers and voting equipment has been delivered to the Election Operations Center in that province and will be handed over. The ECT will keep all items in a safe place, such as a warehouse prepared by the ECT or a police station, where the storage will be monitored 24 hours a day to prevent theft or fraud.

Before Election Day, the ECT officials will transport ballot papers and voting equipment to various constituencies so that each polling station staff will count and check the availability of the equipment first. The tally will be counted at the designated location and will be counted simultaneously with each polling station with observers able to participate for transparency when the counting is done. The transport vehicle will be the vehicle provided by the ECT. To be transported to a warehouse prepared by the ECT or a police station so that it will be transported to each polling station the next day. On election day, at least five members of each polling station committee are appointed, consisting of a Chairperson, an Election Commissioner, and one security guard appointed by government officials to provide security and support for the performance of the Election Commission to collect ballot papers and election materials are checked the day before Election Day at their polling place. The transportation will use the vehicle of the polling station for shipping.

Within seven days from the end of voting on the election day, the constituency Election Commission or the person entrusted by the constituency Election Commission will return ballot papers used for voting, ballot stubs, including spare ballot paper for each polling station in the same place where ballot papers and equipment are stored before Election Day. By providing a report delivery of ballot boxes, documents, and voting materials as evidence to deliver to the Director of Provincial Election when the above actions have been completed. The ballot paper shall be deemed to be under the supervision of the Director of the Office of the Provincial Election Commission. Any action must first be approved by the Director of the

Office of the Provincial Election Commission. Prohibit anyone who does not have the legitimate authority to open the ballot box. Following this phase, there won't be any technology involved to track and trace the ballot paper and this is the gap that this study aims to find the proper technology to use in Thailand's election supply chain. The summary of Thailand's election supply chain can be seen in figure 1.

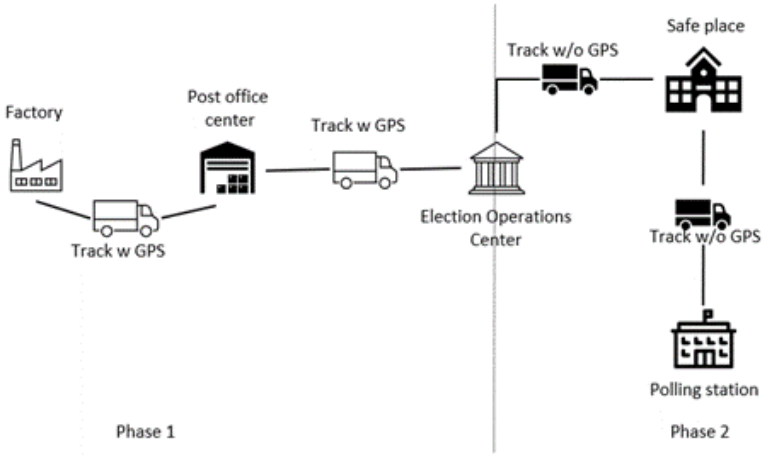

Fig 1. The summary of Thailand election supply chain

3. Literature Review

Blockchain can be applied to a diversity of businesses and strengthen the transparency of the supply chain [2], [3]. Transparency is generally used when describing high-level information in relation to a supply chain. A. Musamih et al. [4] use blockchain to locate the drug in the healthcare supply chain to prevent counterfeit drugs and present all interactions with stakeholders across the supply chain, as well as, U. Barchetti et al. [4] studied the pharmaceutical supply chain in which item detail level traceability is essential to ensure precision in drug movement. This study applies technology called Radio frequency identification (RFID). It is fundamental to implement worldwide standards [5] to trace the movement change of products across a supply chain. Accordingly, the security of the technology can't be overlooked [6], [7]. W.He et al. [6] focus on RFID technology and design a solution for securing the RFID according to EPCglobal standards. RFID is a wireless technology along with a valuable part in auto-identification resolutions that guarantee to substitute the barcode. Altogether, the food supply chain needs precision and guarantee quality and protection in food. Al-Rakhami, Mabrook S. and Al-Mashari, Majed [8] deep drive in the nutrition supply chain to develop this perception and use the internet of things (IoT) is a system of devoted radars connected with the internet that will affect and counteract concerns inside the food industry. This work suggested a traceability framework for IoT. Not only the transparency point but also reliability is important when it comes to selecting technology [9]. G. Alfian et al. are preventing food contamination by proposing an IoT traceability system that applied RFID.

The RFID reader tracks and tracks the product [10]. S. Bahrudin et al., apply a similar solution to the halal product by using RFID and offer a considered technological framework that can assist the whole Halal Supply Chain with tracking and tracing technology [11]. The other reason to implement technology is real-time tracking. Many papers are focusing on

real-time tracking to track the product and can morning in real-time. By utilizing RFID and IoT K. Noinan, S. Wicha and R. Chaisricharoen [12] can morning the weight of a cow in real-time in farming. RFID can return traceability data requests for quantifying in automated real-time data accuracy and is the latest situation in farm management. At the same time, IoT can connect through the internet or mobile phone to perform instant and real-time findings [13]–[18].

To be precise RFID and IoT can integrate with Global Position Systems (GPS) to provide accurate geography location information. R. Chen et al [19] utilize these technologies to detect an automobile and then position it with high-level exactness, which can be utilized to enable numerous applications and facilities in vehicular networks. The last meaning point of technology is the cost of technology. In city public transport, time is necessary for regular transport. M. Yusoff et al. [20] designed an IoT-based together with RFID and GPS to track and supervise bus passengers these systems are to allow effective tracking which is further accessible, less costly, and saves time. The other research identifies at RFID is affordable technology and has low maintenance fees [16], [20]–[22]. One of the research projects wants to track the asset to avoid postponed or misrouted, so they used the Internet of Things and Radio Frequency Integrated Devices to envision and operate essential goods from any place, at any time, on a worldwide scale. The developments in less-power, low-cost wireless communicating tools are suggested in the area of IoT and RFID [23]. Table 1.1 and 1.2 is the summary of factors and table 2 is a technology that this study will focus on.

Table 1.1: The summary of factors

	Why choose the technology solution		
Reference	Transparency and accuracy	Reliability	Cost of Technology
[8]	/		
[18]	/		
[12]		/	
[21]			/
[20]			/
[4]	/		
[9]		/	
[10]		/	
[23]			/
[3]	/		
[2]	/		
[16]			/
[11]		/	

	Why choose the technology solution		
Reference	Transparency and accuracy	Reliability	Cost of Technology
[24]	/		

Table 1.2: The summary of factors

	Why choose the technology solution		
Reference	Real-time data	Standardization	Security
[18]	/		/
[12]	/		
[14]	/		
[7]			/
[19]	/		
[15]	/		
[16]	/		
[5]		/	
[13]	/		
[17]	/		
[6]	/	/	/

Table 2: The summary of technology

		Reference
Technology solution	RFID	[5], [6], [24], [11], [13], [15]–[17], [20], [21], [23]
	GPS	[19], [20]
	IoT	[7], [8], [10], [12]–[14], [16], [17], [23]
	Blockchain	[2]–[4], [9], [18]

4. Methodology

Analytic Hierarchy Process (AHP)

This study intends to evaluate the ideas of selected experts in the tracing and tracking supply chain, technology, and election area, more willingly than the survey of an overall, unnamed public. Hence, utilizing the AHP, which allows the relative significance to be evaluated through relative assessments of factors establishing decision-making, is one of the multi-measures decision-making methods [25], which is used to define meaning when multiple factors for assessment exist. Then, the several alternatives to be considered involving the analysis purposes are distinguished into hierarchies corresponding to the criteria [25]. The relative significance of characteristics that comprise the decision-making hierarchy is accomplished through pairwise comparison. The procedure of evaluating two sets of each factor is called pairwise comparison; a pairwise comparison matrix is positioned, and a reliability test is executed. If the result implies reliability, then the extra analysis is executed by taking into consideration the relative weights broadly. In table 3, a nine-level of importance can be implemented for comparison [25].

Table 3: Shows the meaning of the pairwise comparison

Level of importance	Notation
1	Variants are equivalent
3	The slight benefit of item one over item two
5	The large benefit of the first item over the second one
7	Significantly larger benefit of item one over item two
9	The huge benefit of item one over item two
2, 4, 6, 8	A decision-maker item is between the levels described above

To ensure the consistency of the judgment in all factors, the consistency ratios (CRs) are calculated as follows and CRs should be less than or equal to 0.01.

$$CR = \frac{CI}{RI}\ x\ 100\% \quad (1)$$

Where CI consistency index (CI) is calculated by

$$CI = \frac{(\lambda_{max} - n)}{n-1} \quad (2)$$

Where n is total factors, λ_{max} is the largest eigen factor of the pairwise comparison matrix. RI is the random consistency index which can be seen in table 4.

Table 4: Random Consistency Index (RI)

n	**1**	**2**	**3**	**4**	**5**	**6**
RI	0	0	0.58	0.9	1.12	1.24

According to the previous section, the AHP hierarchical structure is the six basic factors when prioritizing the traceability technology namely, transparency and accuracy, reliability, the cost of technology, real-time data, standardization, and security to consider selecting all four technologies are RFID, GPS, IoT, and blockchain, as shown in figure 2.

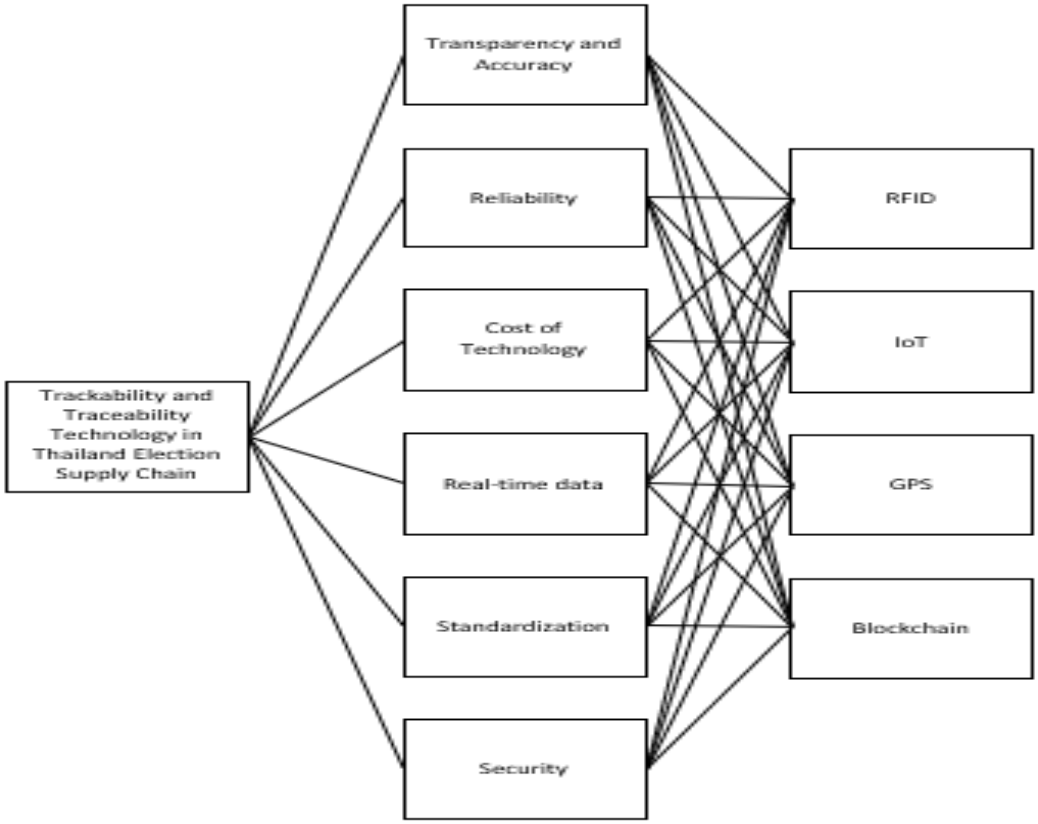

Fig 2: Trackability and Traceability Technology in Thailand Election Supply Chain AHP hierarchical structure

5. Result

The three fields of expertise are supply chain experts, technology experts, and election stakeholders have scored in terms of factors for choosing technology and the technology itself, the results show that transparency and accuracy have the highest weight at 0.39, followed by reliability is 0.22. The standardization was 0.13, while the cost of technology and real-time data have the same weight of 0.09 and the minimum weight was 0.07 for the security factor. Additional information is provided in Table 5.

Table 5: Weight of factor (CR<0.1)

The factor of choosing technology	Weight factor
Transparency and accuracy	0.39
Reliability	0.22
Cost of Technology	0.09
Real-time data	0.09
Standardization	0.13
Security	0.07

In Table 6.1 and 6.2, the results of the weights of each factor in each choice were presented to determine the importance weight of each choice. Then the total priority of alternatives was calculated by weighting each factor for each alternative. and the weight value of the importance of the evaluation criteria for each factor from Table 3. It was found that the most

suitable choice for deciding on Trackability, and Traceability Technology in Thailand's Election Supply Chain is RFID with a weight of 0.47 in Table 7.

Table 6.1: The weights of each factor in each technology

Factor	Transparency and accuracy	Reliability	Cost of Technology
RFID	0.51	0.41	0.55
GPS	0.22	0.22	0.27
IoT	0.15	0.13	0.12
Blockchain	0.11	0.23	0.06

Table 6.2: The weights of each factor in each technology

Factor	Real-time data	Standardization	Security
RFID	0.38	0.47	0.47
GPS	0.16	0.24	0.28
IoT	0.17	0.16	0.17
Blockchain	0.29	0.12	0.08

Table 7: Final weight

Technology	Final weight
RFID	0.47
GPS	0.23
IoT	0.15
Blockchain	0.15

6. Conclusion

In the supply chain of ballot paper in Thailand election process can be described that in the first phase, the ballot is still able to trace and track via Thailand post-GPS but after delivery, the ballot is to each province. The ballot is changed from GPS to manual track, there is no possible way to visualize the movement of the ballot unless need to go to see the location. The aim of this study is to investigate the proper technology to improve this weakness. By using AHP and obtaining the expert's result to determine the technology solution. After reviewing the literature can be explored the factor and technology as sixes factors namely, transparency and accuracy, reliability, the cost of technology, real-time data, standardization, and security. And four technologies are RFID, GPS, IoT, and blockchain to be used in this study. The results show that transparency and accuracy have the highest weight at 0.39, followed by reliability is 0.22. The standardization was 0.13, while the cost of technology and real-time data have the same weight of 0.09 and the minimum weight was 0.07 for the security factor. While RFID has the most weight 0.47, GPS has 0.23, 0.15 for both IoT and blockchain. The result of this can be used to further research to design the new model of Thailand's Election Supply Chain.

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