RESEARCH ON IMPROVEMENT OF PROJECT IMPLEMENTATION FOR RFID TOLL IN MALAYSIA

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FACULTY OF BUILT ENVIRONMENT

UNIVERSITY OF MALAYA

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RESEARCH REPORT SUBMITTED TO THE FACULTY OF BUILT ENVIRONMENT UNIVERSITY OF MALAYA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN PROJECT MANAGEMENT

FACULTY OF BUILT ENVIRONMENT

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Field of Study: Coursework

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RESEARCH ON IMPROVEMENT OF PROJECT IMPLEMENTATION FOR RFID TOLL IN MALAYSIA

ABSTRACT

In line with the Multi Lane Free Flow (MLFF) concept for tolls in Malaysia, the Ministry of Transportation (MOT) and its agency, Malaysian Highway Authority (MHA), wishes to transition the existing toll payment technology in Malaysia from Touch 'n Go (TNG) cards and Smart Tag to RFID Technology Tag and TNG ewallet. MHA's commencement of the MLFF idea was a watershed moment, signaling a strategic change toward information technology industries, paving the way for Malaysia's development as a developed nation. As it began in 2018, the new payment method received some negative feedbacks from the public, including the RFID tag not being detected, payment being deducted twice, barrier gates not opening when the lane is combined with a Smart Tag/RFID lane, and PLUS highway remains unable to accept payment via RFID tag. This research aims to improve the project management implementation of RFID toll payment up to the global standard. The objectives of this research are to analyses existing toll operations to use RFID toll collection systems in Malaysia, determine the issues of existing RFID toll collection in Malaysia and recommend RFID toll system improvement in Malaysia to an internationally accepted standard. It was decided to employ a qualitative research approach, with primary data gathered through interviews with the many parties who are directly involved in the RFID toll payment such as Malaysian Highway Authority, Touch ‘n Go, all toll concessionaires, JPJ and RFID consultant from Taiwan FETC in order to have better understanding with the current toll operations and the root cause of the challenges with RFID toll in Malaysia. The secondary data was gathered from an existing study paper

as well as real-life scenarios from successful countries such as Taiwan and among other sources.

At the conclusion of the research, suggestions were given for upgrading Malaysia's RFID toll to worldwide standards to provide a smooth customer experience.

Keywords: RFID; MLFF; Toll Malaysia; Project Management Planning

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LIST OF ABBREVIATION

RFID	Radio Frequency Identification
MOT	Ministry of Transportation
MHA	Malaysian Highway Authority
LLM	Lembaga Lebuhraya Malaysia
TNG	Touch ‘n Go
JPJ	Jabatan Pengangkutan Jalan
MLFF	Multilane Free Flow
SI	System Integrator
ETC	Electronic Toll Collection
LPT	Lebuhraya Pantai Timur
PMI	Project Management Institute
PMBOK	Project Management Body of Knowledge

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1 CHAPTER 1: INTRODUCTION

1.0 Research Background

Radio Frequency Identification (RFID) is a tag that uses electromagnetic fields to automatically identify and track tags attached to objects. The tags can store electronically information. According to Fatah Chetouane (2015), there are 2 type of RFID tag using in the market nowadays. One is Active RFID tag, and another is Passive RFID tag. Active tags need to have power source such as a battery and may operate hundreds of meters from the RFID reader. Passive RFID tags are not using external power source to detect. It collects energy from a nearby RFID reader's using radio waves to read the tag and activate it. Unlike a strip barcode, RFID tag do not have to be in line of reader sight too read it. As long as it is in the radius of RFID readers, it can be detected.

RFID technology is one of the methods for Automatic Identification and Data Capture (AIDC) in the world. Referring to Fosso Wamba, Samuel & Lefebvre, E & Bendavid, Ygal & Lefebvre, L.A. (2017), RFID Technology is already matured that has been use widely around the world. It is commonly used for supply chain, retails, hospitals, transportation and warehousing. For transportation, RFID technology is used a toll payment in other country such as Taiwan, Brazil, Turkey and USA.

Ministry of Transportation with their agency, Malaysian Highway Authority (MHA) together with Touch ‘N Go (TNG) as the key System Integrator (SI) are set to

embark on a major business transformation initiative, with the ICT and technology transformation being the key enabler towards this (KKR Malaysian ITS Blueprint 2019-2023) .

To support this new direction, leading edge solutions, technologies, methodologies and approaches will be adopted. Technology innovations include the use of Radio Frequency Identification (RFID) with Passive Tag, RFID Reader, TNG ewallet and back end system are set to run this solution.

As this involve of multiple SIs and stakeholders from different Toll Concessionaires, infrastructure readiness, integration with other system and scope management are the key element to ensure the good quality of system developed.

Strong project management is required to ensure project is delivered according to the scope, within given timeline and cost budgeted. In this research, PMI project management approach was used, with the waterfall concept used to complete the project.

1.1 Problem Statement and Research Gap

RFID toll payment concept has been introducing to Malaysian since 2018. Ever since it was introduced, tons of issues happening with negative impact have occurred

despite seamless it is to be (www.thestar.com.my/news/nation/2022/01/18/fadilah-urges-plus-and-TNG-to-solve-rfid-issues).

Every toll concessionaire in Malaysia operates under its own set of standard operating procedures and business regulations. Each toll concessionaire collects tolls using their own mechanism. All systems are linked using middleware to the Central Toll Management System (CTMS) that monitor by MHA. It is linked to the MHA's system for managing toll information (Hashim, 2006). All toll concessionaires must comply with MHA and TNG RFID system requirement.

As all tolls are required to involve in this implementation of RFID toll in Malaysia, PLUS was left out to finalise their involvement in this project. PLUS did not agree to involve in RFID Toll with TNG and decided to launch their own RFID PLUS for their toll only and believe it will offers more choices to the customer. As a result, this has breached the Joint Venture Agreement (JVA) between CIMB, CIMB S1 and PLUS back in 1998 because TNG (wholly owned by CIMB) has introduced TNG RFID earlier. In 2019, PLUS has agreed to involve in TNG RFID toll implementation. As a result of this delay, consumer did not able to pay toll for PLUS via TNG RFID ewallet during earlier stage of implementation. (source: www.bharian.com.my/bisnes/korporat/2018/12/510303/cimb-failkan-permohonan-hentikan-sistem-rfid-plus).

Double deduction was happening when using RFID toll payment recently. Payment for toll using RFID can only be made via *ewallet*. The user needs to ensure to have sufficient balance in their *ewallet* to make toll payment. There are many cases the *ewallet* did double deduction and reimbursement can only be happened in 24 hours. (source: support.TNGdigital.com.my)

TNG ewallet integrates with TNG physical card. User can add their TNG card and link with *ewallet*. Unfortunately, all the transaction history and balance updates are not happening real time. Balance for TNG card will only be updated in few hours or sometimes, on the next day in *ewallet*. This is difficult for people using TNG card to check their current balance compared with Smart TAG especially the consumer using PLUS highway to check their balance in TNG Card in *ewallet*.

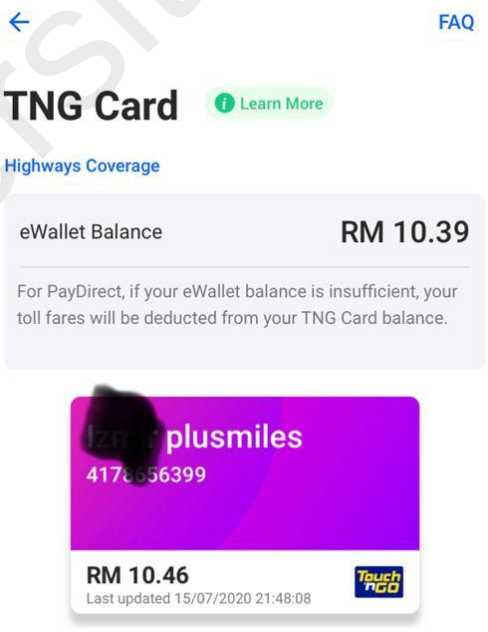

Figure 1: Card balance is not update real-time in ewallet and last updated time and date can be seen on ewallet apps

Some toll concessionaires may lack of funding to enhance their infrastructure to fully comply with the solution given. They required to have high bandwidth internet for seamless transaction to read RFID tag, queries back to back end system and respond back for payment successful. The delay of respond time may resulting delay or barrier gate opening or not open at all.

Merging between 2 payments method in single lane also resulting in a conflict of payment between Smart TAG and RFID. In certain toll, they only have 4 or 5 lanes. Toll concessionaire needs to combine some of Smart TAG lane with RFID lane. As a result, the payment conflict happened between these 2 payments method and payment did not happened either with Smart TAG nor RFID.

In some events, the RFID reader failed to read the RFID tag. This is lead to unopened barrier gate due to unsuccessful toll payment. As a result, traffic is building up behind and create congestion at toll lanes. Referring project working committee MLFF minute of meeting (2019), some of the toll also facing a delay to detect the RFID tag due to uncertain issue and respond to the payment.

During implementation of RFID toll, there is insufficient campaign to introduce new payment method using RFID to the public has been done by Singapore when they introduced ERP back in 1998 (Menon, Gopinath & Guttikunda, Sarath. 2010). TNG did not have any advertisement on media such as television and radio. On top of that, there is no pamphlets was given on how does the payment works for the consumer

every time they are using the highway. As a result, consumer was clueless on how does the payment works and how to report the issue whenever the payment failed.

1.2 Research Aim

The aim of the research is to identify a solution to improve project implementation for Malaysia's RFID toll project.

1.3 Research Objectives

The objectives of this research are as follows: -

1. To analyse existing toll operations to use RFID toll collection systems in Malaysia.
2. To determine the issues of existing RFID system toll collection in Malaysia.
3. To recommend Malaysia's RFID toll system upgrades to an internationally recognised standard.

1.4 Research Questions

Based on research background, this study is guided by three (3) research question as follows:

1. Is existing toll operations in Malaysia be ready to adapt RFID technology for toll collection payment?
2. What is the root cause for toll RFID issue in Malaysia?

3. Is TNG following the established concept RFID toll from successful implemented countries?

1.5 Research Methodology

The researcher conducted this research by using qualitative method with primary data generated from interview with the respective parties who involved directly in this RFID toll payment to understand the existing toll operations, root cause of the issues with RFID toll Malaysia. The secondary data Secondary Data will be obtained from the existing research paper and real case scenario from successful countries such as Taiwan.

1.6 Limitation of the Research

It only focusses on implementing passive RFID for toll only. An active RFID for toll does not include. Passive RFID depending on RFID reader and antenna to retrieve the information inside RFID chip and would not require any power source for RFID tag to respond to it while active RFID would require a minimal power source such as battery to continuously broadcast their location. This usually serve as beacon to transmit real time location to the receiver. As of today, there is no active RFID has been used for toll in the world. The RFID toll that involved in this research mostly all excluding PLUS Closed System toll and Lebuhraya Pantai Timur (LPT).

1.7 Synopsis of the Chapter

The following outline of chapter organize on research study in detail, each chapter will elaborate further the significant of the study.

1.7.1 Chapter 1: Introduction

This chapter highlighting a general introduction to this research with research aim, objectives, purpose of the study, research questions and methodology that will be use and limitation of the study (Qassem, Mutahar. 2014).

1.7.2 Chapter 2: Literature Review

General review of relevant literature with specific topics directly relating to the issue under investigation and how previous research or case study suggest on the relevant to this study. The gap in the research will be filled with paper from literature reviews.(Paltridge and Starfield, 2007)

1.7.3 Chapter 3: Research Methodology

Research methodology is a line-up of items and identified steps that require to perform the research with research design, method to use for data collection, method for data analysis, details on how when why and who. (Paltridge and Starfield, 2007). It can be considered as a research path which will design a direction to researcher in

conducting their research. It shows the journey through to formulate problem statement and objectives and result from data obtained during the study period.

1.7.4 Chapter 4: Data Collection and Analysis

The data collection will be collected base on the research design to gather input through research methods which are then verified. Tt includes data analysis and result, questionnaires and output from the methodology.

1.7.5 Chapter 5: Discussion

Finding is a sets of data collection base from the output gathered as a result from research methodology. It was intended to answer the problems of the study. The discussion will be carried out in detail by using the outcomes of the previous findings.

1.7.6 Chapter 6: Conclusion and Recommendation

Through conclusion and recommendation, the data analysis is being conclude and exemplified base on study aim and objectives. All the findings will be summarize in this chapter together will the recommendations.

1.8 Conclusion

In the end of the research, researcher will be able to understand the real situation for all tolls in Malaysia and the chronology behind it during implementation of RFID and able to compare with other countries on how they managed to overcome this issue and determine best practice to use for RFID toll in Malaysia base on the scenario cases globally.

2 CHAPTER 2: Literature Review – Project Management Concept, RFID and Electronic Toll Collection System

2.0 Project Management Framework – PMI Methodology

2.1 Introduction

Project management is the systematic process of managing work efficiently and effectively to deliver plan result. Project management target to complete the objectives according to the agreed scope, within budget and agreed timeline. On top of that, there are a few elements that are important in project management that contribute to the success factor of one project.

PMI is an organisation that promotes a project management approach that has been successfully implemented and used throughout the world. For the most part, project management techniques such as PRINCE 2, APM, IPMA, AIPM, and Agile have been utilised in conjunction with one another. The PMI Methodology, on the other hand, is the most widely recognised internationally. The waterfall concept forms the base for the PMI Methodology. Figure 2 shows the waterfall project management lifecycle.

Figure 2: PMI Project Management Lifecycle (Kathy Schwalbe 2012, Managing a Project Using an Agile Approach and the PMBOK® Guide)

PMI has introduced 10 Project Management Knowledge and documented it as a guideline in their PMBOK. 10 knowledge management areas are:

- Project Integration Management
- Project Scope Management
- Project Schedule Management
- Project Cost Management
- Project Quality Management
- Project Quality Management
- Project Resource Management
- Project Communication Management
- Project Risk Management
- Project Procurement Management
- Project Stakeholder Management

In this research, Researcher only assess planning for 3 knowledge areas in PMBOK which are Plan Scope Management, Plan Quality Management and Plan Stakeholder Engagement.

2.1.1 Project Planning

Planning is the most crucial phase in project management lifecycle. All of the 10 area PMBOK knowledge are involves in planning, PMI PMBOK 6th Edition (2018). Project Planning in Scope Management Plan consist of develop scope management, collect requirements and define scopes. For project Quality Management only consist of Plan Quality Management and stakeholder is Plan Stakeholder Engagement.

Table 1: Project Management Process Group and Knowledge Area Mapping (Kim Heldman, 2013)

Knowledge Areas	**Project Management Process Group**				
	Initiation	**Planning**	**Execution**	**Monitoring & Controlling**	**Closing**
Project Integration Management	Develop Project Charter	Develop Project Management Plan	Direct and Manage Project Work	Monitor and Control Project Work	Close Project or Phase

			Manage Project Knowledge	Perform Integrated Change Control	
Project Scope Management		Plan Scope Management Collect Requirements Define Scope Create WBS		Validate Scope Control Scope	
Project Schedule Management		Plan Schedule Management Define Activities Sequence Activities Estimate Activity Durations		Control Schedule	

		Develop Schedule			
Project Cost Management		Plan Cost Management Estimate Costs Determine Budget		7.4 Control Costs	
Project Quality Management		Plan Quality Management	Manage Quality	Control Quality	
Project Resource Management		Plan Resource Management Estimate Activity Resources	Acquire Resources Develop Team Manage Team	Control Resources	
Project Communicat		Plan	Manage	Monitor	

ion Management		Communications Management	Communications	Communications	
Project Risk Management		Plan Risk Management Identify Risks Perform Qualitative Risk Analysis Perform Quantitative Risk Analysis Plan Risk Responses	Implement Risk Responses	Monitor Risks	
Project Procurement Management		Plan Procurement Management	Conduct Procurements	Control Procurements	

Project Stakeholder Management	Identify Stakeholders	Plan Stakeholder Engagement	Manage Stakeholder Engagement	Monitor Stakeholder Engagement	

Table 2: PMI Process Chart for each Phase (Kim Heldman, 2013)

Initiating	**Planning**	**Executing**	**Monitoring & Controlling**	**Closing**
Select Project Manager	Determine development approach, life cycle and how you will plan for each knowledge area	Execute work accordingly to the project management plan	Take action to monitor and control the project	Confirm work is done to requirement
Determine company culture and existing system	Define and prioritize requirements	Produce product deliverable (product scope)	Measure performance against performance measurement baseline	Complete final procurement closure

Collect processes, procedures and historical information	Create project scope statement	Gather work performance data	Measure performance against other metrics in the project management plan	Gain final acceptance of product/services
Divide large project into phase or smaller projects	Assess what to purchase and create procurement document	Request changes	Analyse and evaluate data and performance	Complete financial closure
Understand business case and benefits management plan	Determine planning team	Implement only approved changes	Determine if variances warrant a corrective action or other change request	Hand off completed product/service
Uncover initial requirement, assumptions, risks, constraints and existing agreements	Create WBS and WBS dictionary	Continuously improve; perform progressive elaboration	Influence factor that cause change	Solicit customer's feedback about project

Assess project and product feasibility within the given constraints	Create activity list	Follow process	Request changes	Complete final performanc e reporting
Create measurable objectives and success criteria	Create Network Diagram	Determine whether quality plan and processes are correct and effective	Perform integrated change control	Index and archive records
Develop project charter	Estimate resource requirements	Perform quality audit and issue quality report	Approve and reject changes	Gather final lessons learned and update knowledge base
Identify stakeholder and determine their expectations,	Estimate activity duration and costs	Acquire final team and physical resources	Update project management plan and project document	

interest, influence and impact				
Request changes	Determine critical path	Manage people	Inform stakeholder all the change request results	
Develop assumption log	Develop Schedule	Evaluate team and individual performance; provide training	Monitor stakeholder engagement	
Develop stakeholder register	Develop Budget	Hold team building activities	Confirm configuration compliance	
	Determine quality standards, processes and metrics	Give recognition and rewards	Create forecast	
	Determine team charter and all roles	Use issue log	Gain customer's acceptance of interim deliverable	

	and responsibilities			
	Plan communication and stakeholder engagement	Facilitate conflict resolution	Perform quality control	
	Perform risk identification, qualitative, quantitative, risk analysis and risk responses planning	Release resources as work is completed	Perform risk reviews, reassessment and audits	
	Go-back iterations	Send and receive information and solicit feedback	Manage reserves	
	Finalize procurement strategy and documents	Report on project performance	Manage, evaluate and close procurements	

	Create change and configuration management plan	Facilitate stakeholder engagement and manage expectation	Evaluate use of physical resources	
	Finalize all management plans	Hold meetings		
	Develop realistic and sufficient project management plan and baselines	Evaluate seller, negotiate and contract with sellers		
	Gain formal approval of the plan	Use and share project knowledge		
	Hold kick off meeting	Execute contingency plans		
	Request changes	Update project management plan and		

		project document		

2.1.2 Project Integration Management

Project Integration Management consists of the processes, tasks and activities to identify, define, combine, and coordinate multiple processes in project management tasks within the Project Management Process Groups. In the project management context, integration includes characteristics of unification, consolidation, communication, and interrelationship. These actions will be used from beginning of the project until closure phase. Project Integration Management consists of few elements.

In modern IT project management, AGILE will be used especially when it comes to system development project (Wang, Li-Chih & Lin, Sian-Kun & Huang, Li-Ping. 2009). RFID for toll is also adopting AGILE since it is system project. But planning is using waterfall concept. They are still using AGILE approach to get the system ready for testing (Sim, Liew & Bakar, Amir & Ahmed, Falah & Jamal, Arshad. 2019). A project management information integration system can be viewed as the responsibility of the project owner anticipating the benefits of the project (finance, quality, flexibility, and innovation) (Badewi, Amgad. (2016). As an example, it might become apparent that, although it originally seemed sensible to integrate the existing financial and maintenance systems, it turns out that it would be more cost effective to

get a new maintenance system that already has a built-in integration with the current finance system. However, recent research efforts on sustainable project management recognize the importance of sustainability integration in project processes (Aarseth, 2017). This thinking emerged from the Labuschagne and Brent argument in 2005 (Labuschagne, Carin & Brent, Alan. (2005) that the project lifecycle and deliverability of the project demonstrated that the sustainability of deliverables is shaped by the project processes.

2.1.2.1 Develop Project Charter (Initiation Phase)

The process of developing a document that formally starts the project with endorsement from the project sponsor. Project charter consists of 1-2 pages document that has info on the title of project and description, nominated project manager, business case, resource assign, key stakeholders, high level deliverables, assumptions/exclusion, project issue and potential risk and exit criteria. Project charter will be developed usually by project manager and signed by project sponsor before the project commencement.

2.1.2.2 Develop Project Management Plan (Planning Phase)

Develop Project Management Plan is the process of defining, preparing, and coordinating all plan components and consolidating them into an integrated project management plan. All of 10 elements in PMBOK will be highlighted in project management plan and distribute to all the project members and key stakeholders to tell them the information about this project. The important of project management plan is to define the basis of all project activities and how the work will be conducted.

2.1.2.3 Direct and Manage Project Work (Execution Phase)

This is the integration part of the executing process group. In Direct and Manage Project Execution, the project manager integrates all the executing processes into one coordinated effort to accomplish the project management plan and produce the deliverables. In addition to completing the activities and deliverables in the project management plan, Direct and Manage Project Execution involves requesting changes and completing the work accompanying approved change requests.

2.1.2.4 Manage Project Knowledge (Execution Phase)

Manage Project Knowledge is the process of using existing knowledge and creating new knowledge to achieve the project's objectives and contribute to organizational learning. The key benefits of this process are that prior organizational knowledge is leveraged to produce or improve the project outcomes, and knowledge created by the project is available to support organizational operations and future projects or phases.

2.1.2.5 Monitor and Control Project Work (Monitoring & Controlling Phase)

Monitor and Control Project Work is the process of tracking, reviewing, and reporting the overall progress to meet the performance objectives defined in the project management plan. The key benefits of this process are that it allows stakeholders to understand the current state of the project, to recognize the actions taken to address any performance issues, and to have visibility into the future project status with cost and schedule forecasts.

2.1.2.6 Perform Integrated Change Control (Monitoring & Controlling Phase)

Perform Integrated Change Control is the process of reviewing all change requests; approving changes and managing changes to deliverables, project documents, and the project management plan; and communicating the decisions. This process reviews all requests for changes to project documents, deliverables, or the project management plan and determines the resolution of the change requests. The key benefit of this process is that it allows for documented changes within the project to be considered in an integrated manner while addressing overall project risk, which often arises from changes made without consideration of the overall project objectives or plans, This process will be done until the end of the project.

2.1.2.7 Close Project or Phase (Closure Phase)

Close Project or Phase is the process of completing all final activities for the project, phase, or contract. The key benefits of this process are the project or phase information is archived, the planned work is completed, and organizational team resources are released to pursue new endeavours. This process is performed once or at predefined points in the project.

2.1.3 Project Scope Management

Scope Management is the process to define what activities are agreed to be delivered in detail. All of the scope must be capture and documented so it can be used as a reference in future in any case someone asking about what is include the scope

and what is the exception. This can avoid change request project that will always incur more cost and delay to the project if it is not manage carefully.

2.1.3.1 Plan Scope Management (Planning Phase)

Plan scope management consist of how the activities can be achieve, what tools can be used (Microsoft project, JIRA, ServiceNow) to manage project successfully, how to create work breakdown structure (WBS), how the scope can be manage and controlled and ways to obtain sign off. During this phase, requirements management plan document will be generated. Requirement Management Plan document also refers as business analysis plan.

2.1.3.2 Collect Requirement (Planning Phase)

Collecting requirements are important to the project. Information inside project charter, agreement and project management plan only consist high level of requirement only. Actual requirements are coming from important stakeholders that involve directly and indirectly to this project. Few of the method can be used to collect requirement such as brainstorming with project team and stakeholders, interviews, focus group, questionnaires and survey, benchmarking and voting. Requirement Traceability Matrix will be generated by the end of the phase to compile the requirement from who and what is the priority of that requirement.

2.1.3.3 Define Scope (Planning Phase)

Define Scope is the process of developing a detailed description of the project and product. The key benefit of this process is that it describes the product, service, or result boundaries and acceptance criteria. In the end of this process, project scope statement will be generated will all the deliverables for this project. The document will keep updating along the way then new requirement has added into the project.

2.1.3.4 Create Work Breakdown Structure (WBS) (Planning Phase)

Creating a Work Breakdown Structure is a structure that breaking down all the major task with different category and split it into small work packages. All the tasks and work packages will be assigned with an identifier such as number or acronyms. This is easier to segregate the activities and work package and assign resource to it. In top of it, cost can be easier to be determined with using this WBS because we can calculate the cost base on work package, go up to activities and project. This is call bottom-up costing.

2.1.3.5 Validate Scope (Monitoring & Controlling Phase)

Validate scope in project is the activity involve frequent meetings with customers or stakeholders to obtain formal approval of deliverables during project monitoring and controlling. This is important to ensure all of the scope are captured and no change request will be raised in future to avoid project delay and incur more cost.

2.1.3.6 Control Scope (Monitoring & Controlling Phase)

Control scope involves measuring and assessing work performance data against scope baseline and managing scope changing. The scope must be clearly defined and confirmed so it won't be any additional scope adding into this project. Adding additional uncontrolled scope from time to time is called scope creep. Scope creep shows that the requirement gathering and define requirement are not properly captured and understand. Scope creep can result poor project progress because spending time on reviewing additional scope, stray away from initial scope and incur more cost if it is not control carefully.

2.1.4 Project Quality Management

Quality is subjective in project. In project management, quality means level of acceptance of the product/services that has agreed with the customer. Some customer that has a tight budget may sacrifice high quality of end result due to high cost and degree of priority.

2.1.4.1 Plan Quality Management (Planning Phase)

Quality management is following organizational standard and customer standard to ensure project is meeting their expectation. Normally quality define as meeting requirement no extra effort require. Project Manager must understand the quality management process and put into project management plan to improve it continuously.

Gold platting is a concept a project team is providing extra effort, function, high quality and better performance for free to the customer. Gold platting is not recommended in project because this additional extra work will risk the project being delay and waste of effort. Quality must be planned not waiting for it failed and take action. It must be proactive instead of reactive.

Continuous improvement (kaizen) is recommended in project to finding a way to become better for next project. Continuous improvement in project can classify as how quality management will be planned better next time and utilize on project.

Another approach for continuous improvement is six-sigma. Six-sigma is a methodology for achieving organizational process improvement and high level of correctness. Methodologies that is using in six-sigma is called DMAIC. It stands for Define the problem and project goal, Measure detail the various Measure in detail the various aspects of the current process Analyse data among other things and find the root defects in a process, Improve the process and lastly Control how the process is done in the future.

2.1.4.2 Manage Quality (Executing Phase)

There are few ways to manage quality in RFID toll project management. Checklist, fishbone diagram, document analysis, root cause analysis, audits and problem solving. In this phase, quality reports will be generated to show level of quality and acceptance level of the product or services.

Mcfarlane, Duncan & Sheffi, Yossi (2003) highlighted the obstacles and barriers that have prevented a mass adoption of RFID technology. One of it is data storage and access must be capable to process huge data and amount faster in real time without any missing information.

2.1.4.3 Control Quality (Monitoring & Controlling Phase)

Control quality in project means controlling certain level of quality within deliverable. Most of the common use to control quality in technology RFID is questionnaires and survey from the user, performance review and inspection.

Referring to Abugabah, Ahed; Nizamuddin, Nishara; and Abuqabbeh, Alaa (2020), RFID does not work efficiently with metals or liquid. In quality control, this is one of consideration needs to take consideration to test it although RFID tags use UHF electromagnetic waves as a medium of communication.

2.1.5 Project Stakeholder Management

Project Stakeholder Management includes the processes required to identify the people, groups, or organizations that could impact or be impacted by the project, to analyse stakeholder expectations and their impact on the project, and to develop appropriate management strategies for effectively engaging stakeholders in project decisions and execution. The processes support the work of the project team to analyse stakeholder expectations, assess the degree to which they impact or are impacted by

the project, and develop strategies to effectively engage stakeholders in support of project decisions and the planning and execution of the work of the project

2.1.5.1 Identify Stakeholder (Initiation Phase)

The process of identifying project stakeholders regularly and analysing and documenting relevant information regarding their interests, involvement, interdependencies, influence, and potential impact on project success. Identify stakeholders started as early as initiation phase while approving the project charters. This is because the stakeholders are the one who providing the requirement to start the project. Stakeholders identify through questionnaires, brainstorming to identify additional stakeholders and stakeholder analysis.

2.1.5.2 Plan Stakeholder Engagement (Planning Phase)

The process of developing approaches to involve project stakeholders based on their needs, expectation, interests, and potential impact on the project. Basically, stakeholders are divided into 4 group of criteria. Which are high power high interest, high power low interest, low power high interest and low power and low interest. (Kim Heldman, 2018).

Stakeholders can the best key elements to ensure project success and failure of project. Managing relationship with stakeholders are the key to this successful story of RFID for toll in Malaysia. Plan stakeholder engagement requires MHA to strategize about approach to involve all stakeholders into this project. From the list of stakeholder

register that has been develop during identify stakeholder, best to classification them base on their criteria. Figure 3 shows 4 type of engagement base on their level of power and interest in this project.

Outcome from the analysis, research finding by Moura, Helder and Teixeira (2010) enlighten project stakeholder, groups or organizations may influence the project planning, design, implementation of project. Project manager from MHA should keep stakeholder well informed on what is the status of project progress before any changes to be happened. (Moura, Helder and Teixeira, 2010).

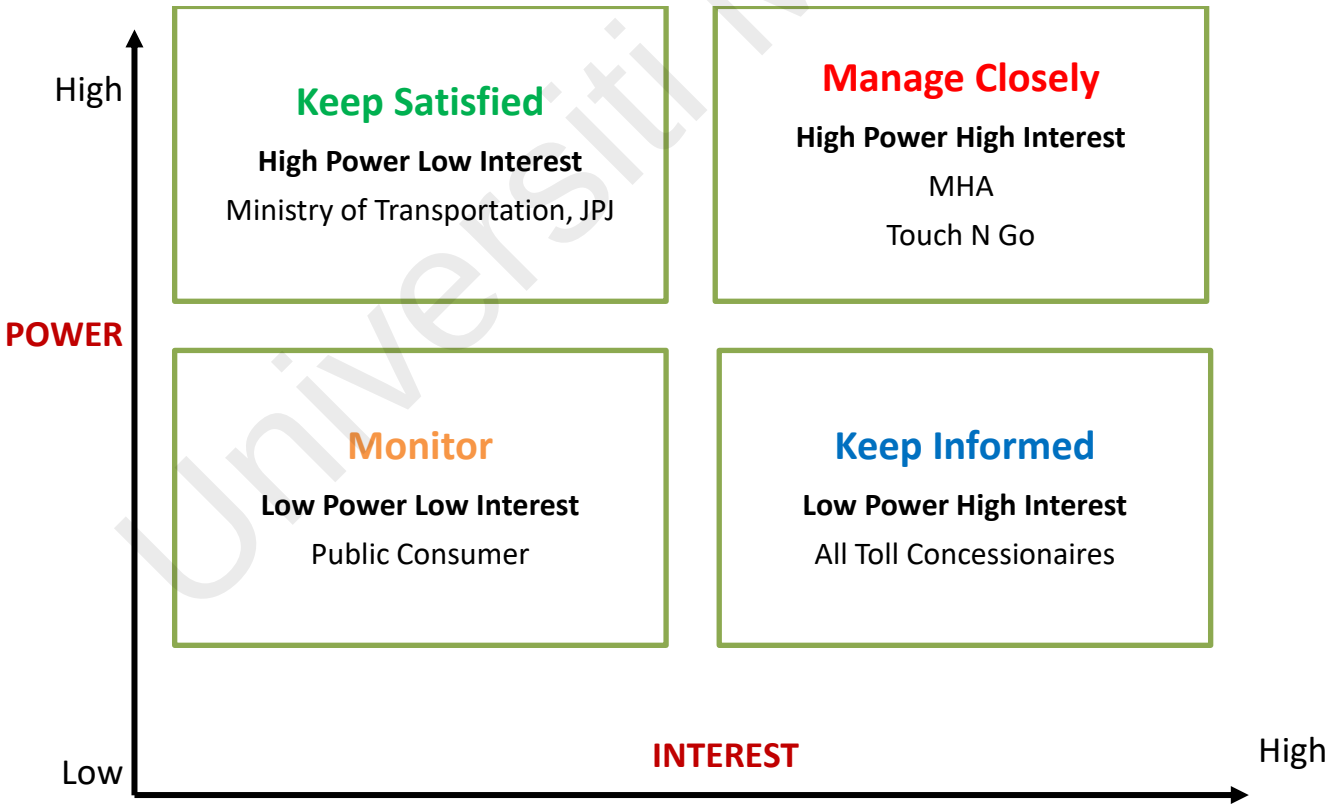

Figure 3: Power-Interest Matrix (PMI PMBOK 6th Edition, 2017)

Referring to Figure 3 for Power-Interest Matrix, the level of their power and interest determined as per their involvement of the project. Public consumer has low power and low interest in this project as they are not directly involve with the project and only received the technology solution that has been agreed between project committee which are MHA, TNG and all toll concessionaires. They need to be kept monitor as their voices in the media could impact the implementation of this solution in future.

All toll concessionaires has high interest as they involve directly in the project but has low power as the solution for RFID toll will be planned and execute by TNG together with MHA. Toll concessionaires need to be kept informed on the direction of the project and any changes required. TNG and MHA held the higher power and interest the project and it was monitored by MHA and TNG as the implementer of this solution.

JPJ has high authority and power over the RFID project but they did not has involvement directly with this unless the enforcement of people not paying toll implemented. They need to be keep satisfy and updated as in future this solution may bring impact to their enforcement plan.

2.1.5.3 Manage Stakeholder Engagement (Execution Phase)

The process of communicating and working with stakeholders to meet their needs and expectations, address issues, and foster appropriate stakeholder engagement

involvement. As we identified the interests, expectations and influence of the stakeholders and relates them to the purpose of the project, we need to managing the engagement of the stakeholders to keep them checked and involve in the project. The PMBOK® Guide states "to identify stakeholder relationships that can be leveraged to build coalitions and potential partnerships to enhance the project's chance of success, along with stakeholder relationships that need to be influenced differently at different stages of the project or phase" (p. 395). PMBOK mentioned to consider the level of influence each stakeholders (using a stakeholder analysis) for active stakeholder management and focusing on the relationships necessary to ensure the success of the project. (Sims, R. L. & Kramer, S. B. (2015).

2.1.5.4 Monitor Stakeholder Engagement (Monitoring & Controlling Phase)

The process of monitoring project stakeholder relationships and tailoring strategies for engaging stakeholders through the modification of engagement strategies and plans.

2.2 Toll in Malaysia

2.2.1 History of Toll in Malaysia

Back in 1966, government has started planning and initiated the first toll highway in Malaysia under Ministry of Works and Communications. The project was governed by The Highway Planning Unit. It was 60 kilometres toll highway from Tanjung Malim to Slim River. A year later, few tolled highways were opened which are Federal Highway Route 2 to connect from Port Klang to Kuala Lumpur which is

45 kilometres distance and also Sultan Yahya Petra Bridge was the first bridge toll in Kota Bahru Kelantan. In this year also, East-West highway has been commencement from Gerik, Perak to Jeli, Kelantan which covers distance of 167 kilometres (Official data from MHA, Archived 2012-03-21).

2.2.2 MHA Roles

In 1980, The Highway Planning Unit has proposed to establish a Malaysian Highway Authority (MHA) under the same ministry to monitor the works and administration of all expressway. All the administration of highway in Malaysia is under MHA. MHA roles are to monitor and executed the design, construction, operation, regulation and operation as well as maintenance of connecting highways in Malaysia (LLM Corporate Info website). A responsible to provide a guideline for a highway operation and ensure all the toll concessionaires follow the standard operation procedures. On top of that, frequent meeting is happening between MHA, JPJ and MOT to discuss anything related to the road transportation and highway.

2.2.3 Toll Concessionaires in Malaysia

According to The Edge Markets (2019), Malaysia have almost 20 tolls concessionaire operation all tolls in Malaysia. All of toll concessionaires are following the requirement and regulation that has been advised by MHA. PLUS are the biggest toll concessionaires in Malaysia which covers from North to South and Klang Valley area. List of name of the toll concessionaires can be found in table 3 below.

Table 3: List of Toll Concessionaires in Malaysia (theedgemarkets, 2019)

Owners of the major highways in Malaysia

HIGHWAY	SHAREHOLDER	TRAFFIC VOLUME IN 2017 (MIL)	TRAFFIC VOLUME IN 2016 (MIL)	GROWTH (%)
NSE	PLUS	550.03	548.55	0.27
Elite	PLUS	119.17	116.3	2.47
LDP	Litrak	162.28	166.51	-2.54
SPRINT	Litrak	74.01	75.91	-2.5
Kesas	Gamuda and PKNS	123.13	124.84	-1.37
SMART	Gamuda and MMC Corp	8.19	9.02	-9.2
NPE	UM Corp	69.37	68.59	1.14
Besraya	UM Corp	56.13	54.38	3.22
Lekas	UM Corp	24.77	23.32	6.22
DUKE	Ekovest	50.18	47.03	6.7
LATAR	Bina Puri	25.19	24.55	2.61
MEX	Maju Holdings	51.99	48.72	6.71
Grand Saga	Taliworks Corp and EPF	51.78	49.69	4.21
Grand Sepadu	Taliworks Corp and EPF	32	32.39	-1.2
SILK	Prolintas	69.15	70.84	-2.39
Guthrie	Prolintas	38.84	38.46	0.99
AKLEH	Prolintas	18.84	19.51	-3.43
SUKE	Prolintas	NA	NA	NA
DASH	Prolintas	NA	NA	NA

*Gamuda owns a 43.58% stake in Litrak

2.2.4 Electronic Toll Collection for Highway in Malaysia

In 1994, PLUS has introduced PLUS TAG as an Electronic Toll Collection (ETC) as the payment method. There was a lot of ETC has been introduced such as Express TAG for Shah Alam Expressway, FasTrak for Damansara-Puchong Expressway and Sprint Highway as well as Saga Tag for Cheras-Kajang Expressway. In 1999, TERAS Teknologi Sdn Bhd (A service provider for toll collection system for PLUS) has developed an advance ETC called SmartTAG that leverage on infra-red technology to transmit the signal from the SmartTAG battery-powered-device to the

infra-red transceiver mounted at the toll plaza. This system was designed to process up to 1,200 vehicle per hour and used a sole ETC method for all toll in Malaysia in 2003. According *to* Ir. Ismail Md. Salleh, En. Khair Ul-Anwar Mohd Yusoff,, Pn. Zaida Bt. Abdul Aziz (2006), SmartTAG expended the usage for security entrance access for residential area in 2004 and parking payment years after that.

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2.2.5 Toll Operation in Malaysia

In Malaysia, each tolls concessionaire operates on their own standard operation according to their own business rules. Some of the toll only have 4 lanes and some of them have up to 10 lanes depending on the traffic and numbers of vehicle use the highway. In general, although all of them operate with their own business rules, they are still following the standard that have been circulated by MHA.

2.2.6 Current Toll Payment in Malaysia

Current toll payment in Malaysia is using cashless payment. User will pay the toll either using Touch N Go card, SmartTAG card or RFID tag that linked to their ewallet. Once user has made the payment at the toll plaza, the transaction is being kept in plaza toll system and pass to the HQ. From HQ, the transaction will pass to TNG system for any transaction.

2.3 RFID Technology

2.3.1 Introduction to RFID

RFID is stands for a Radio Frequency Identification. It is a tiny tag with chip electronic devices that consists of a tiny chip and also small antenna. The chip is capable to store almost 2,000 bytes of data (Tanim, M M Zaman. 2016).

The RFID tag works as the same purpose as a bar code or a magnetic strip on the back of an ATM card or credit card. Each of RFID tag provides a unique identifier for that object. The RFID tag must be scanned first time to activate and retrieve the data.

The main purpose is to deliver the information, carrying attachment or identification. Of all methods, a bar code has always been first option to use around the world and RFID is become substituted product of it. RFID is a tiny tag containing an integrated circuit chip and an antenna, and it has the ability to respond to radio waves transmitted from the RFID reader in order to send, process, and store the information of objects such as industrial containers, palettes, individual products and also human objects.

RFID has been widely used around the world for all industry. Majorly it has been used for logistics and tracking purpose. While RFID has more advantages than bar code, many aspects that are still lack of it that businesses still consider not using

it. Base on the performance, RFID systems is good compared to all other Auto ID systems such as barcode, smartcard, and Optical Character Recognition Camera. Major company has recognized the advantages of RFID and recently moved to introduce the technology by establishing processes to push all suppliers to use RFID as well. With emerge of global standards and reduction in tag costs, RFID tag has proved to provide many advantages which is increased visibility and accuracy together with labour cost deduction.

Few years back, most of the world's largest retailers and government agencies such as Wal-Mart, Amazon, e-Bay and the Department of Defence of America introduced mandates for RFID acceptance. Wal-Mart believes that RFID can reduce its cost of labour and inventory costs. Wal-Mart also thinks that revenues will be increased limit the out-of-stock items across its stores around the world. Due to the high purchasing power and influence in retailer's industry and global suppliers, Wal-Mart has ability to achieve this potential to create a driving force to push for RFID acceptance in the world.

2.4 Overview of Multi-Lane Free-Flow (MLFF) Toll

2.4.1 Concept MLFF in Malaysia

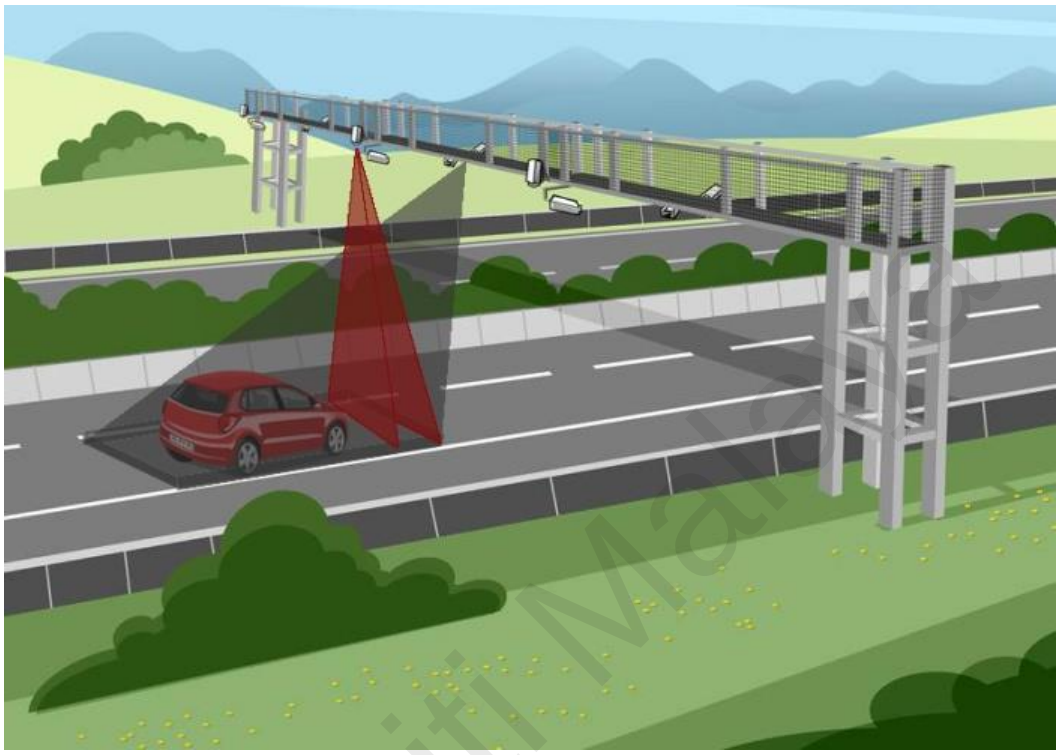

Figure 4: Multi-Lane Free Flow Toll Concept (Portal Rasmi Lembaga Lebuhraya Malaysia)

Figure 4 depicts the MLFF concept for the Toll in Malaysia. Malaysia is now targeting to move towards physical Toll booths as per Figure 5 below. In order to move towards that technology, few aspects need to be considered to get the system running smoothly.

Figure 5*:* Current Toll Concept in Malaysia (PLUS Malaysia website)

With new RFID solution, firstly Malaysia will transform the existing card payment to use RFID cashless payment. Next, in few years government will remove the toll both to change to gantry concept which is what has been called Multilane Free Flow.

2.4.2 Touch ‘N Go ewallet Mobile Application

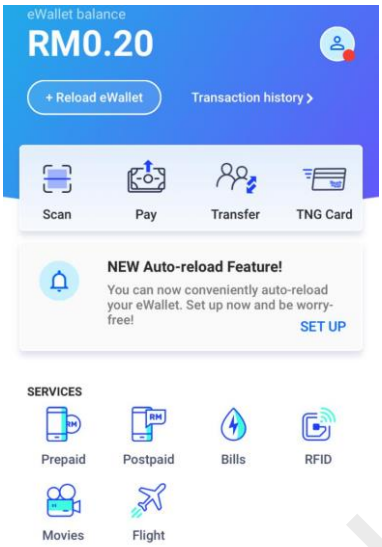

Figure 6*:* TNG ewallet mobile application (TNG Malaysia Apps)

According to Touch N’ Go’s website, RFID toll can only be paid by using Touch ‘N Go ewallet Apps as shows in Figure 6. Driver must have sufficient balance in their ewallet apps in order the payment can be made, The MLFF lanes shall be equipped with Touch ‘N Go reader to collect toll payment. Each of toll transactions is updated in real-time in Touch n Go ewallet once the payment deducted to see the remaining balance.

Top up the ewallet can be performed at the application itself. It has few methods such as credit card top up, online banking top up, transfer the balance from other ewallet and TNG reload pin top up that can be bought at petrol kiosk and 7-eleven. The user also be able to set auto top up at certain amount for their convenience.

Receipt of each transaction can be viewed and downloaded from the ewallet itself for record purposes. Besides that, it also has other function such as pay utilities bills, prepaid top up, movie ticket, parking and shopping.

2.5 ETC using Passive RFID for MLFF in Other Country

Each MLFF systems are different for one country to another country and for inside of the country as well. The framework and solution are depending on the system stakeholder's requirement for each country. There are few countries have implemented this solution across the world. In this section, few of the country's solution have been stated to demonstrate their solution based on passive RFID solution for ETC.

2.6 Reason of Using RFID as a Toll Payment Solution

As well known, RFID technology is a matured technology that widely used in warehousing and access cards. ETC has been introduced back in early 90's as an electronic toll payment. RFID is used as an ETC due to few reasons. According to research (Anish, Parag, Manish, Darshan, 2014), it can minimize the queue at plaza toll by increasing plaza booth service turn around rates. This means, compared to cash payment and manually reload in plaza toll, customer can reload the *ewallet* for RFID at anytime and anywhere using online banking or credit card. RFID also has capability to scan more than 1000 items in 1-2 seconds.

RFID has capability to store up to 1024bits of data. It is sufficient to store the car information and owner information inside the RFID tag. Passive RFID tag require low cost to manufacture and maintain. RFID can be encrypted and decrypt for security purposes to ensure it will not be read by unauthorize parties. In future, MOT has plan to embed road tax into RFID chip according to former Deputy Transport Minister, Datuk Aziz Kaprawi (2015).

Malaysia is adopting Taiwan RFID toll concept and system. Although it is not 100 percent similar to Taiwan's MLFF concept, the technology and capability is almost as efficient as Taiwanese RFID. This can be seen when MHA appointed FETC (Taiwan sole ETC company) as a consultant to RFID toll in Malaysia. The reason we want to benchmark Taiwan with Malaysia is because they have implemented RFID toll way earlier than Malaysia and experience 10 years in RFID for toll.

2.7 Comparison RFID Toll for Other Country

2.7.1 Taiwan

2.7.1.1 Introduction of toll in Taiwan

The RFID based ETC technology has been introduced in Taiwan in 2012. Taiwan National Freeway Bureau (TANFB) together with system implementer FETC have migrated the traditional toll into passive RFID-based ETC system in year 2012. According to Eugene Chao (2015), the ETC MLFF Taiwan currently serves for 7 million vehicle owners with 331 MLFF gantries with roughly around 14 million transactions per day. The front-end system integrates with other hardware in one

gantry. Taiwan ETC uses open 6C standard technology, Enforcement Violation System integrate with Automated License Plate Recognition (ALPR) and Audit system. Taiwan's RFID ETC able to supports different toll pricing for various type of vehicle that based on toll areas, transaction date and time, journey distances and a combination everything Eugene Chao (2015).

Taiwan has 2 major highways which are freeways and expressway. Freeway operates differently from other countries. Although it charges based on vehicle kilometres travel (VKT), flat rate zero charges will be charged nevertheless any vehicle that travel in freeway less than 20 kilometres per day. (Eugene Chao, 2015). FETC is responsible for the Taiwan freeway ETC total solution, including front-end and back-end systems as well as business model, from planning, designing, building, testing, and operation.

Figure 7*:* Taiwan ETC expressway gantry base on distance, area and type of vehicle.

(source: fetc.net.tw/en/OurOperations/ElectronicRoadpricing.html)

2.7.1.2 Technology of Taiwan ETC

The solution system of Taiwan RFID ETC is connected to the independent Service Operators Toll Management System that connects back to the CTMS that manages by the Government of Taiwan. ETC Taiwan consists of six components which are eTag, Road Side Unit (RSU), vehicle featured base and speed detector RFID. Enforcement system (CCTV), accounting system (Direct Debit Sensor) and Main Control Unit (MCU) are part of the backend called Dedicated Short-Range Communication (DSRC). The DSRC Microwave system includes three major components: on board unit transponder (eTag), road side transceiver (Reader), and transceiver antenna. Sometimes, road side transceiver and transceiver antenna may combine into a single unit, called beacon (CIT, 2006). Besides RFID ETC, Taiwan's RFID solution is also can be used for Smart Parking Toll System, Electronic Road Pricing System, Real Origin Destination Matrix Collection (Traffic Data Collection) System, Route Guidance System and Traffic Reporting. (https://www.roc-taiwan.org/public/USlax_en_events/5860173671.pdf)

2.7.1.3 Taiwan Toll Enforcement

When vehicle passing through the gantry, the RFID sensor will check the eTag license, vehicle plate number, and the license holder's bank account information whether they are all matched. The direct debit sensor will charge the vehicle via eTag. During eTag reading, the vehicle is suggested to drive 120 kilometres/hour or else the transaction may fail. Once transaction failed, enforcement cctv will captured the plate number to ensure payment will be made.

2.7.1.4 Challenges in Technology

Bandwidth and transmission speed plays a decisive role during the data exchange process. Lower bandwidth will affect transmission speed between reading tag and send to backend to process. If the bandwidth is not enough, data may not able to transmit successfully (Yu, 2004).

RFID Reader distances and electric power plays an important part to capture the eTag. Reader's electric power, eTag sensitivity rate, antenna radius configuration, and distance between the eTag and reader have a strong association with the data transmission. If the Reader is installed in an open area, without any intervention, the decrease of electric power of the reader is inversely proportional to the square of distance. If the Reader is installed in an inner area, the reflection will generate multiple paths and the decrease of reader's power is inversely proportional to the fourth power of distance (Yu, 2004).

As DSRC-Microwave performs well, it is also has disadvantage. At first, electronic wireless may be affected by surroundings (Eugene Chao, 2015). Example, if the angle is more than 20 degrees or in a uneven surface land, the road side transceiver may receive plenty of wireless signals from transponder because of physical diffraction and interference. Secondly, the antenna would not be able to penetrate metal surfaces. As a result, the transponder and the transceiver are usually installed outside of vehicles.

According to Eugene Chao (2015) as well, the transceiver antenna exists blind side. Antenna may have problem to detect vehicle from different several angles.

Generally, while configuring the reader, engineers had to spent time to testify and find the best location to configure the wavelength. This may increase overhead cost of the project. A final disadvantage is that the mismatch record between the enforcement system and DVR-camera system may potentially cause payment problems for the driver such as payment toll failed. The following scenarios demonstrate how payment problems could happen.

Usually, most microwave systems can only be used for single lane to detect vehicle feature and collect toll. If a SUV mistakenly enters passenger car lane, rather than SUV lane, the driver immediately realizes it and quickly shifts to the SUV lane. The DSRC Microwave system may not be able to charge the right toll based on vehicular size. Then, the driver would face two situations. One is that the system regards SUV as a passenger car and the system charged SUV as a passenger car toll rate, rather than SUV toll rates at first. The driver needs to pay an extra toll for the remaining difference (Eugene Chao, 2015).

Another situation is even though the enforcement system successfully distinguishes vehicle feature as a SUV and charged it correctly. However, the digital video recorder (DVR) camera camera1 record SUV as a passenger car, but DVRP camera2 had no record, instead the SUV visual record shown on DVRSUV camera1 and DVRSUV- camera 2 (Figure 8). This inconsistency creates an inconvenience for drivers. To solve this pricing and image mismatch, the driver needs to provide eTag identification code and driver's ID as well as historical records to MOTC-Bureau of Freeway.

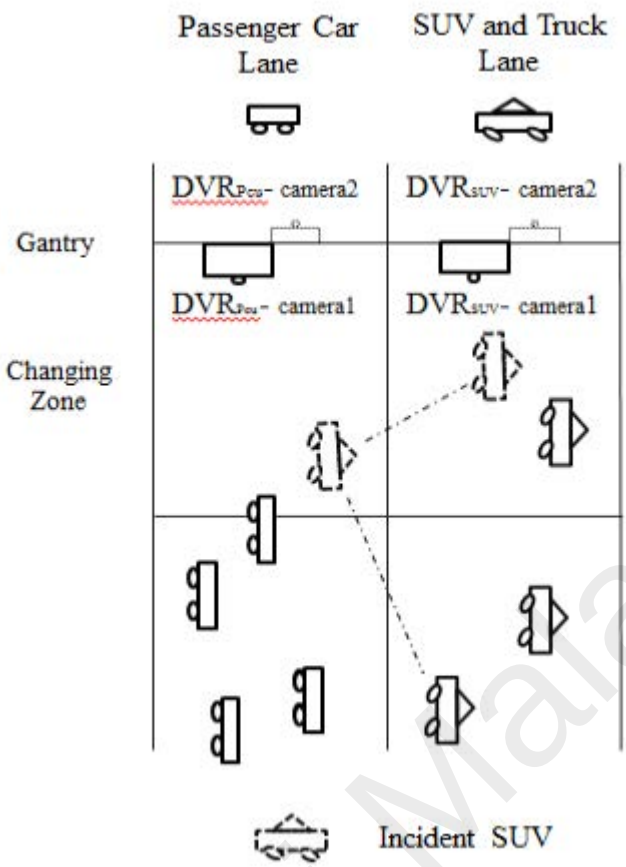

Figure 8*:* Example scenario for SUV and Truck changing lane in Taiwan (International Case: Road Pricing Policy and Electronic Toll Collection (ETC) in Taiwan Freeway)

2.7.2 Brazil

2.7.2.1 Introduction of Toll in Brazil

Brazil is one of the countries that implemented passive RFID for ETC as this is the cheapest solution can be provided to the public. In 2013, Sao Paulo has rolled out the RFID RTC solution which consists of 19 Highway Toll Concessionaires, members of Sao Paulo Transportation Agency (ARTESP) (Plugtests Technical Report, 2013).

According to Acura Website Brazil, The SINIAV (Automatic Vehicle Identification System) is an initiative of the Federal Government coordinated by DENATRAN (National Traffic Department). Its main goal is to improve vehicle traffic in major Brazilian cities. For this, there are the processes of control, control of the Brazilian fleet, electronic toll collection, traffic flow, mobility and security, especially in large cities, through the electronic identification of vehicles by RFID in the frequency 915Mhz. Traffic has been one of the main problems in the metropolis of Brazil. Traffic jams or jams are still the most talked about, but we must not forget the problems that exist in the entire transportation system, represented here with cargo thefts and private vehicles, toll queues and lack of traffic safety .

Figure 9: SINIAV by Acura as the RFID Implementor in Brazil

(https://www.acura.com.br/en-us/technology/siniav-en-us)

All the toll concessionaires are working independently, but the system is leverage on the same RFID tag for all toll concessionaires' company. Toll concessionaires have been provided the specification for the infrastructure and should replicate the solution. The Front-End toll concessionaires will integrate with Central Toll Management (CTMS) that is managing by the government to serve all the qualified toll concessionaires. Apart from that, the system is also have been used to integrate with other system such as vehicle identification, vehicle classification and vehicle violation systems (Thober. Dr. Dario Sassi, 2012).

2.7.2.2 Technology for Brazil ETC

Referring to Thober. Dr. Dario Sassi (2012). This system foresees the insertion of electronic chips in the vehicles so that they are identified and tracked, electronically, by antennas strategically placed in the cities. Such antennas will send information to the processing plants that will check the status of the vehicle being analysed, such as vehicle cloning, fines, licensing and IPVA. With the operation of the project in a positive way, soon we will have more peace of mind when traveling through the streets and avenues of the big cities. In addition to reducing congestion, it will be possible to better manage vehicle traffic and prepare roads to support growing volumes in the flow of vehicles, both within cities and on the roads .

DENATRAN G0 (ARTEFATO also required) IAV RFID readers, installed in toll plazas, urban porticoes, street posts and columns, will collect board, chassis, model and manufacturing information for the processing locate and track vehicles with special treatment, stolen, cloned, irregular or unmanageable, manage congestion, control the emission of pollutants, monitor, among numerous other possibilities to improve the quality of life. SINIAV provides for integration with the Point-to-Point System of the State of São Paulo and with the Brazil ID project and provides for the use of the technology by private companies in agreement with Denatran. This integration preserves investment through infrastructure sharing (Denatran's Website).

All tolls concessionaires are using system middleware to integrate and connection with front End reading systems to CTMS. CTMS works as a hub to provide fully support to all the system integrator companies that is involve in integration works and operation support for all department. It provides fully support from RFID tag,

RFID readers, and infrastructure to toll operators and Government. The systems integrate from all toll concessionaires to CTMS and have approximately 10 million transaction every month (Plugtests Technical Report, 2013).

Figure 10*:* Sao Paula Electronic Toll System, Brazil MLFF (Wernher Von Braun labs Website)

2.7.3 Turkey

Turkey rolled out the ETC using passive RFID-Based back in 2012. The ETC system consists of 2000 km national highway network and supports approximately of 11 million users. The current system is called 'Fast Passing System' or Hızlı Geçiş Sistemi - HGS was migrated from the previous Automatic Passing System technology. The system is linked with an electronic central back-office payment system for reliability of infrastructure to ensure vehicle validation and enforcement is effective (Noriani, 2015).

2.7.3.1 Turkey Toll Enforcement

Turkey's HGS system is leverage on Automated Number Plate Recognition Cameras for enforcement. Vehicle that does not have any RFID tag yet, penalty will be imposed to the defaulter. The system is connecting to government's CTMS that provide real-time data, calculation and transmission of the toll transaction. The toll concessionaire's back-end system has around seven central server and computer centres that connect using high speed fibre-optic cable and satellite network. The CTMS architecture is able to comprise of traffic violation, enforcement system, integration with banking system, and ability to integrate with various types of payment services and toll collection system.

2.7.4 Singapore

Back in 1998, Singapore implement Electronic Road Pricing (ERP) for their toll collection system with multilane free flow (MLFF). This is resulted by their manual road pricing system that leads to congested traffic mostly in the city since 1975. Singapore is one of the first county implement toll payment without stopping the vehicle for toll payment.

An ERP in Singapore consist of 2 sets of technology for toll payment. One is dedicated short range wireless system to communicate with the In-vehicle Unit (IU) devices that placed inside the car or on motorcycle to read the information in the IU from the gantry. On top of that, the gantry was installed with Automatic Number Plate Recognition (ANPR) camera to read the license plate number from vehicle in case ERP reader failed to read the IU especially foreign cars that doesn't have the IU.

All Singaporean cars must be equipped with IU for enforcement purpose as well. In any case Singaporean cars do not have IU, there is a $70 penalty will be imposed each time driving through operating ERP. In any situation motorist does not have sufficient balance in their IU passing through active ERP, a fine for $10 will be issued to the owner plus the fees of the ERP charges must be made to Land Transport Authority (LTA).

As Singapore rolled out their ERP system, government has launched a mass public campaign to inform and educate motorist on the ERP scheme. A banners, pamphlets and advertisement everywhere were aggressively communicated to the motorist before it was implemented. A three-month pilot testing has been conducted to the motorist once they have installed their IU to the vehicles. With zero fees toll charges and expecting feedbacks from the motorist, LTA received a lot of feedbacks and able to fix the bug and issue before it was started charges to the motorist. As a result, the error rate was low at 0.03% and violation was about 0.7%. This shows the implementation of new technology in Singapore toll system is reliable with good implementation planning.

2.8 Malaysia RFID for Foreign Car – Vehicle Entry Permit Project (VEP)

In 2019, Malaysia has implemented automated system for the enforcement of Vehicle Entry Permit (VEP) for all vehicles and Road Charges (RC) for foreign vehicles entering Malaysia (source from JPJ website Malaysia). It is the intention of Ministry of Transportation (MOT) through Jabatan Pengangkutan Jalan Malaysia (JPJ). This project has been implemented in both Malaysia – Singapore border at

Bangunan Sultan Iskandar (BSI) and Kompleks Sultan Abu Bakar (KSAB) (KKR Malaysian ITS Blueprint 2019-2023).

To support this direction, leading edge solutions, technologies, methodologies and approaches will be adopted. Technology innovations include the use of Radio Frequency Identification (RFID) and Optical Character Recognition (OCR) camera system and fully integrated with the RC and VEP system.

How does RFID for Malaysia VEP works is, as the vehicle passes through the loop sensor, the Lane Control System (LCS) simultaneously triggers the RFID Antenna to read pertinent data (i.e Tag ID) from VEP RFID tag and IP camera to capture the image of the vehicle. The Automated Number Plate Recognition (ANPR) engine residing in LCS swiftly determines the vehicle registration number from the captured image (System Technical Specification Document VEP , *2018*).

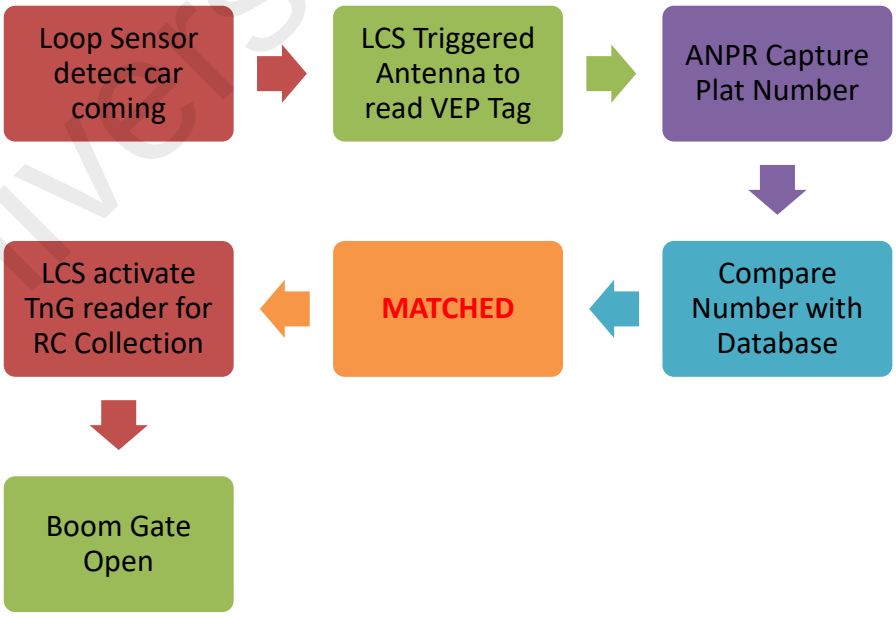

Figure 11: Process Flow of RFID Technology for VEP and Road Charge Malaysia (System Technical Specification Document VEP, 2018)

Based on the Tag ID, the vehicle registration number is retrieved from the database and compares against the ANPR result. If the two data matches, it can safely conclude the identity of the vehicle and determine its origin and category. In the event the two data do not match, the driver will be asked to press the intercom for further instruction. The driver of said vehicle will then be ushered to the JPJ counter. If the vehicle is private and foreign owned, the LCS activates the Touch N Go reader for RC collection. For each transaction, the system is designed to charge one-time RC even though the driver may tap the Touch n Go card more than once. Boom gate opens automatically if the RC payment is successful. For local vehicles and vehicles that are exempted, the Touch N Go reader will not be activated and boom gate opens automatically.

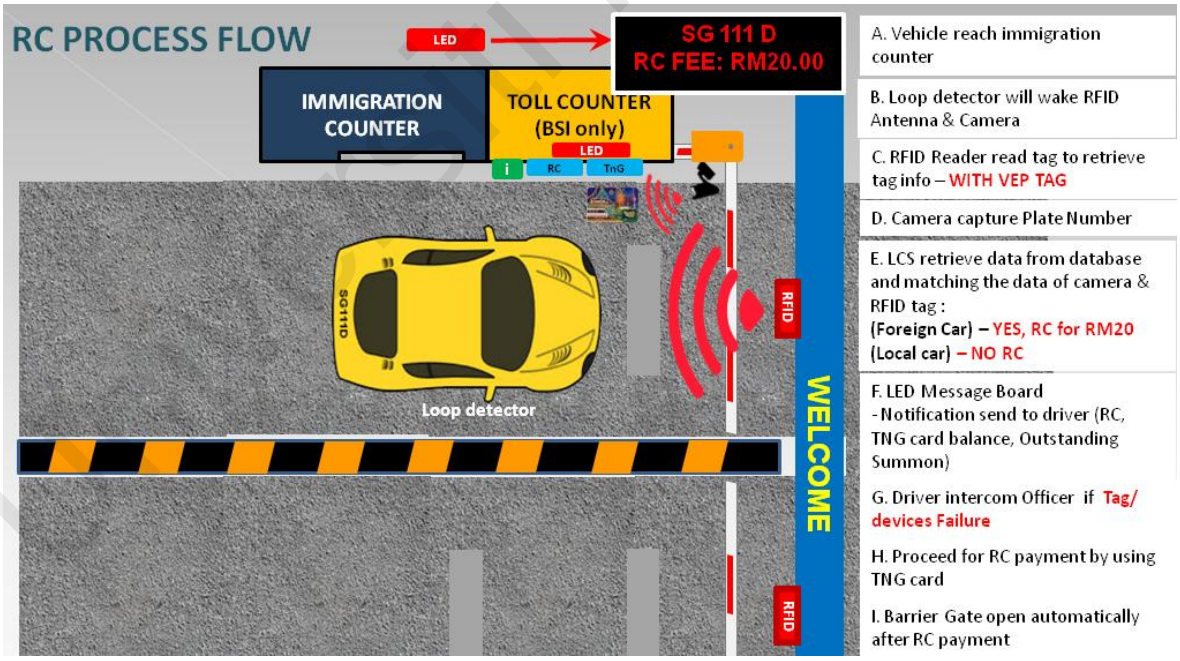

Figure 12: Overview of RFID Technology for VEP and Road Charge Malaysia (System Technical Specification Document VEP, 2018)

There are ANPR cameras and RFID devices installed at the inbound and outbound checkpoint border of Malaysia to identify and monitoring vehicle that is not register with VEP system automatically. When a vehicle without a tag passes through the loop sensor, the LCS simultaneously triggers the RFID Antenna to read pertinent data (i.e Tag ID) from VEP tag and IP camera to capture the image of the vehicle. In this scenario, the camera will read the vehicle registration number and LED message board will direct the driver to pay RC while foreign vehicle registration number captured and recognized by the ANPR camera.

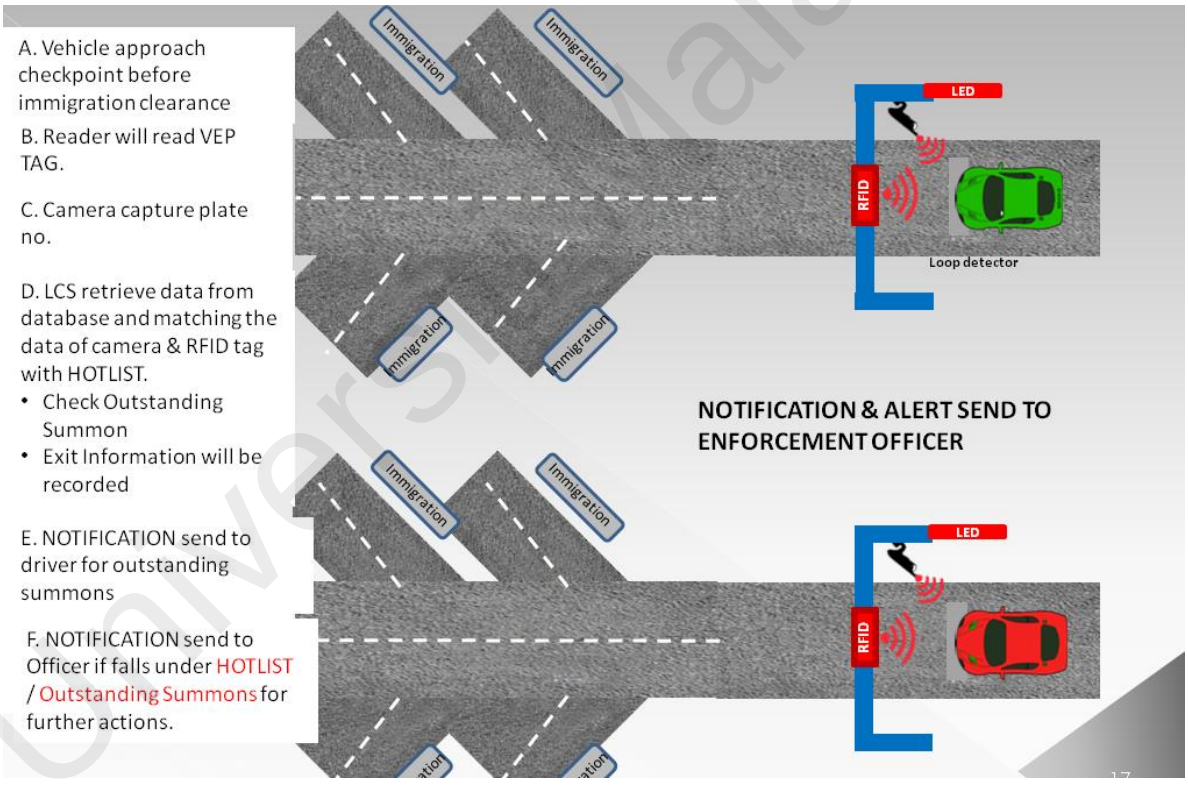

Figure 13: Overview of outflow RFID Technology for VEP and Road Charge Malaysia before pass through Malaysian Immigration (System Technical Specification Document VEP, 2018)

At the same time, TNG reader will be activated for RC payment. After payment deduction, the LED message board will display the TNG card balance and notify the vehicle driver to register the vehicle, collect and install VEP tag and pay processing fee at JPJ counter. The vehicle driver may press intercom if any assistance needed from the officer in the Command Control Centre (CCC).

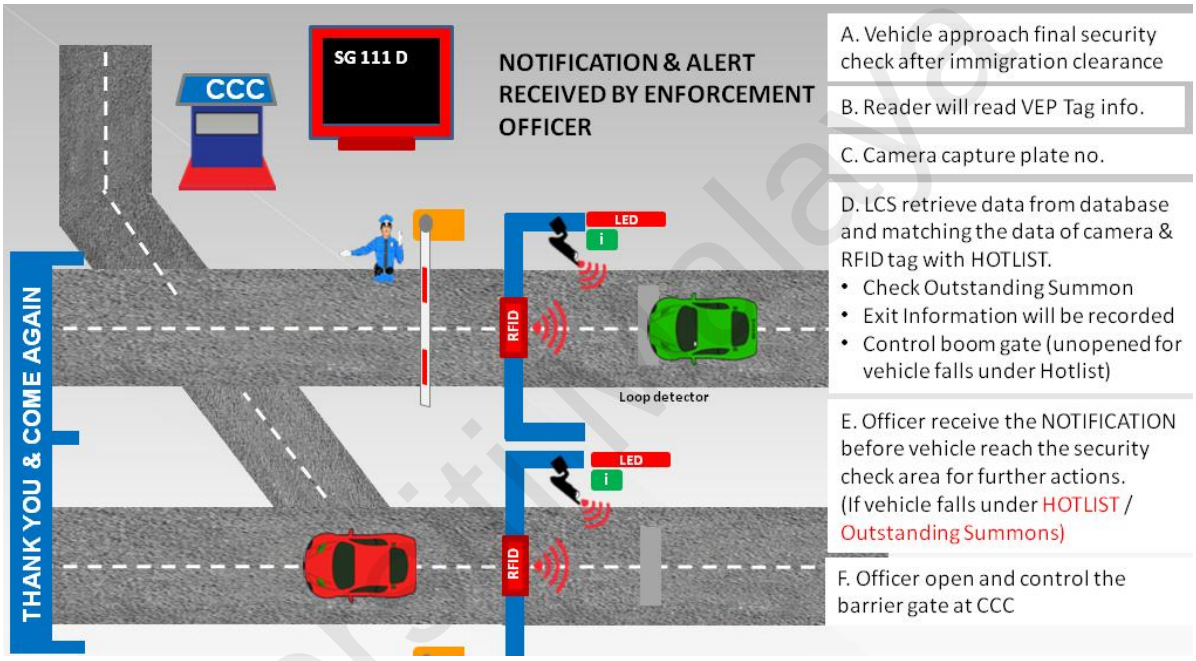

Figure 14: Overview of outflow RFID Technology for VEP and Road Charge Malaysia after passed through Malaysian Immigration (System Technical Specification Document VEP, 2018)

2.9 Comparison

By stating the architecture of these three countries mentioned, most of country are using the same concept of passive RFID technology with different system integrator that connects to government but slightly different on the technology and

vehicle needs. As for ETC Taiwan, it only has two highways that interconnected, and both are managed by a sole concessionaire which is the government. Funding for all ETC highway implementation cost is by private sector and control the operations and revenue collections. Government has to ensure that everyone pays the toll fare, or a penalty will be imposed to the defaulter. Three levels of architecture are using which is the Front-End System, Service Toll Concessionaires Management System and Central Toll Management System (CTMS).

For Brazil, the government is running the Central Toll System but not limited to single system. Government allows Toll Service Operators to have their own infrastructure and system, but Front-End System will connect back to Central Toll System. Brazil has also three-layered architecture which are Front End System using middleware to connect by the toll concessionaires to the Central Toll System. Hence, the middleware system will be developed and implement by the Toll Operators itself.

For the 2000 KM highways in Turkey, it has seven regional toll systems operator that connected to the central back end system and running by one operator that managed by system provider who provides the whole solution from front end to centralized back end systems. Three layered architecture has been implemented as well which are the Front-End System, Regional System and Centralized Back End System that connecting to each other. Table 2 shows the summary of 4 countries of system implementation and architecture including Malaysia as well.

Table 4: Summary of systems implementation and architecture by country

Country	Rolled Out Year	Highway Authority	Operator	Solution Archictecture
Brazil	2013	Government	Toll Service Provider	3 levels (Lane system, Regional system, Central Toll system)
Turkey	2012	Government	System Provider	3 levels (Lane system, Regional system, Central Toll Management System)
Taiwan	2013	Government	Toll Service Provider	3 levels (Lane system, Regional system, Central Toll system)
Singapore	1998	Government	System Provider	3 levels (In Vehicle Unit, Local Controller Housing, Central Computer System)
Malaysia	2018	MHA	Toll Service Provider	5 Levels (Lane system, Plaza System, Regional system, HQ system, Central Toll system)

3 CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides an explanation of the methodology used in this study. Specifically, the techniques for data collection, the procedures for data collection, the sample procedure, and the interview procedure will all be covered in detail in this chapter.

3.2 Research Design

A plan to execute the specific research calls research design or research architecture. According to Welman J.C & Kruger S.J (1999) research design is how researcher plans to gather the information from the subjects and compile the outcome from the subjects. The researcher will develop the plan, as well as the method in which it will be presented, in order to present the findings and conclusion of this analysis. For the purpose of this research, a qualitative research methodology was employed.

During research design, the targeted sampling are based on the parties involve directly in the existing toll operations in Malaysia, which is all the toll concessionaires to know the day-to-day operation activities on the toll payment. A payment solution and project implementer which is TNG to understand on how the payment work and project planning. MHA as the leader for the project to oversee overall activities on progression of the implementation of RFID toll payment. Major highway in Malaysia

is PLUS which is has been represented by TERAS Teknologi Sdn Bhd (a system integrator for PLUS highway) to understand the issue that has been happening during implementation of RFID toll and involvement of enforcement party which is JPJ in future. As Malaysia is still new to RFID toll collection system, a solution consultant from Taiwan which is FETC will be interviewed as well to obtain the feedback on what can be improve for RFID toll in Malaysia.

3.3 Quantitative and Qualitative

In research, there are 2 methods that will be used which are Quantitative and Qualitative method.

3.3.1 Quantitative Research

A type of educational research in which the researcher decides what to study, asks specific, narrow questions, collects quantifiable data from participants, analyses these numbers using statistics and conducts the inquiry in an unbiased, objective manner. Quantitative research is mostly used to consolidate the data from numerical data or questionnaires. The reason of using quantitative research is to develop the mathematical model and numerical hypothesis pertaining to each research. Quantitative data usually represent in numerical manners such as statistics, numbers and percentage.

The researcher usually will conduct a research by using objective question, level of agreement and true false opinion. Data is fixed, and the respondent would not be able to give any information beyond what is stated in the sets of questionnaires.

3.3.2 Qualitative Research

Qualitative research will be using unstructured or semi structured technique to perform data collection. Some common methods are including focus group by taking sampling of demographic or geographic, observations and interview.

Qualitative research is conducting by asking the respondent regarding the respective events. The researcher will ask few sets of question to the respondent by conducting and interview to gather the feedback and information. Data gathered can be subjective and might stray from the question but might be relevant to the research topic.

By using qualitative research, the researcher will be flooded with huge amount of information to understand the overall picture of the event by explanation from the respondent during the interview. Information will be explained starting from the beginning of the event until to each detail of the event.

3.3.3 Quantitative Research vs Qualitative Research

Table 5*:* Comparison between qualitative and quantitative (Ray C. Anderson 2010)

Qualitative	Quantitative
Researcher may only know rough idea in advance what to look for.	Researcher knows exactly what need to be looked.
The aim is to get the complete and details description.	The aim is to classify features, count it, and construct statistical models in an attempt to explain what is observed.
It usually happens during the initiation phase of research.	It usually happens towards the end phase of the research.
Data gather using interview to collect any information that might related.	Researcher using tools to conduct this such as SPSS and questionnaires to collect numerical data.
The design emerges as the study unfolds.	All aspects of the study are carefully designed before data is collected.
Data represent in the form of words or pictures to do explanation.	Data represent in the form of numbers and statistics to present.
Data gather in less time, broad information and less able to generalize.	Data is accurate, efficient, and able to test the hypothesis but may miss important information.
Data is subjective. In depth interview and interpretation of important events.	Data is objective. Usually data is fixed to whatever things that needs to be focused such as survey and questionnaires.

3.4 Technique Data Collection

In this research there are two type of data are collected. Preliminary and secondary data are used for further investigation in this study. Preliminary data are collected through meeting with project team members (TNG, all SI, MHA and Consultant), MOT and JPJ. Secondary data are collected from all the case studies, journal and articles that have been published as a guidance to the relevant topics.

3.4.1 Primary Data

Primary data are new data collected for a study derived from the actual location of an incident. In other words, primary data are the data obtained from the original source. Raw data needs to be analysed after it was collected. Primary data also can be obtained directly from respondents either through questionnaires or interviews. In this research, semi-structure interview was only made to get primary data to construct specific problem statement and used as the main instrument to collect the needed data to be analysed in order to achieve the objective of the research.

3.4.2 Secondary Data

Data collection through secondary sources are usually use for reference, more detail understanding regarding theoretical information, getting the whole picture of the research and collection of past research as guidelines. Secondary data also available online and in other mass media or publication channel. Secondary data is data that has been gathered and can be accessed by the public. Examples of common sources are

the existing secondary data such as data collected by government public services departments, libraries and Internet. The secondary data that is used for this research are from the articles extracted from the Web of Science, Scopus, Emerald, Google and business proposal. The use of secondary data is useful to support the research, establishment of the research and deeper understanding of the research area.

3.5 Narrative Research

Narratives word itself defined as a story, tale and recital of facts which has been told by first person (Myers Micheal, 1997). Narrative analysis is a method of collecting the description of events through interview and observations. It focuses to understand human experience through their explanation (Riessman, C. K. 1993). This approach is usually used to synthesize a data from interview feedback and re-write again with elaboration to present the outcome. This method also requires to analysis the written reference documents. The outcome is defined as why that certain events happened. Narrative research has been used to collect data from different parties (internal or external) to gather the outcome from different perspective of people. The content of the interviewees' will be analysed according to researched interpretation.

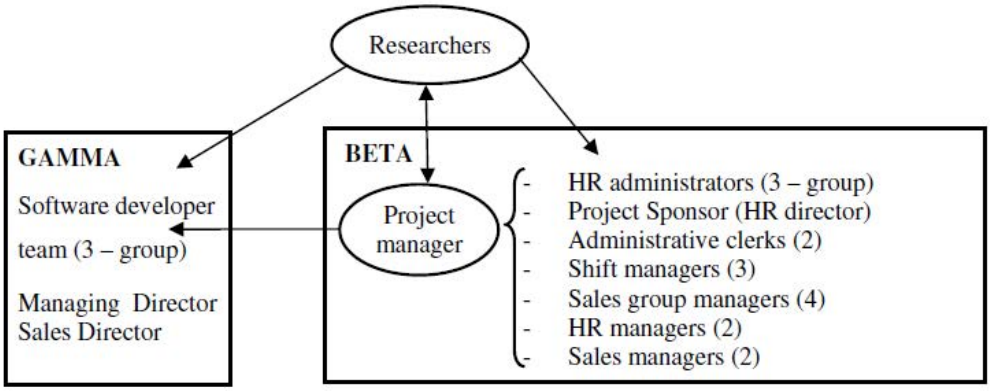

Figure 15*:* Data collection in the two organisations and number of interviewees (Mitev, Nathalie & Bartis, Eszter. 2008)

3.5.1 Interview

Interviews is one of qualitative research technique that describe as conducting question and answer with the small number of respondents to obtain their feedback on some events, idea, thoughts and situation. It divided into three type of interview formats which are structured, semi-structured and unstructured.

3.5.1.1 Structured Interviews

Structured interview will be conducted as a series of pre-determined questions that will be answered by interviewees answer in the same order. The result and findings can be more straightforward because researcher is being able to compare all the answers by interviewees although same question being asked.

3.5.1.2 Unstructured Interviews

Unstructured interview is least preferable and reliable from research perspective due to no standard questions are prepared prior to the interview and data will be collected in an informal manner. Unstructured interviews tend to be bias depending on who is the interviewee and it is difficult to analyse as different sets of questions might be asked to different people.

3.5.1.3 Semi-structured Interviews

Semi-Structured interviews consist of combination both structured and unstructured interviews into 1 interview. For semi-structured interviews, researched will prepare a multiple question in single set and will be answered by all interviewees. On top of that, additional, additional questions could possibly be asked during the session to understand better about the explanation and expand further for certain issues.

3.6 Thematic Analysis

Qualitative method with thematic analysis is always being used as a combination to gather data analysis for researching. This analysis in qualitative research is the most often used to analyse the gathered data. Thematic analysis applicable to do data analysis of set of manuscript such as interview transcripts, reference and books. Researcher will interpret closely and examines all the data gathered to identify the similarity of the themes which are keyword, ideas, patterns and topic that repeatedly mentioned in the document. Below are the steps of conducting thematic analysis.

1) Familiarizations
2) Coding
3) Generate Theme
4) Reviewing Theme
5) Define Theme Name
6) Write Up

Thematic analysis is being used for Information Technology (IT) project for research of implementation of collaborative software in enterprise in German (Petra Schubert, Susan P. Williams 2012), which they are using thematic analysis to process the pattern coding into meaningful theme and few major categories. They were conducted a research to investigates few implementations of project of collaborative systems to identify processes, structures and activities correlated with perform changes.

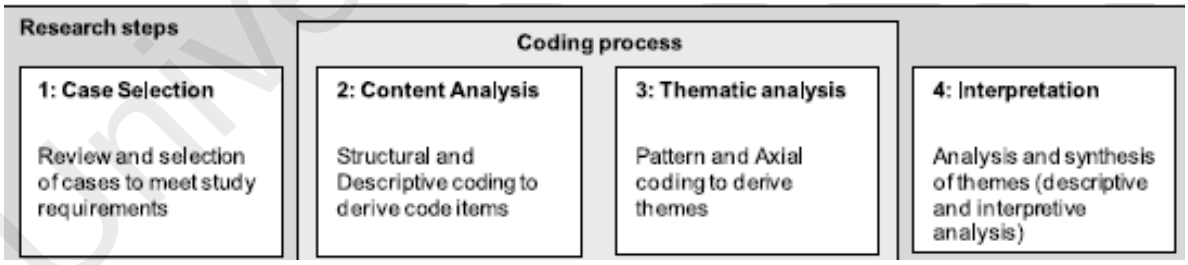

Figure 16: The research design structured into 4 research steps leveraging on thematic analysis (Petra Schubert, Susan P. Williams 2012)

This concept is similar with this research for RFID for toll system as both has similarity in project implementation for IT. This research analyses the data from the

result of interview of 5 parties and code it together into few themes, define the theme and start writing up.

3.6.1 Familiarization

Data will be read and familiarize with all the data that has been gathered. All the mistake will be checked before any extraction to do coding. Credibility of data will be checked as well to ensure it is correct.

3.6.2 Coding

Coding will be conducted with highlighting any interesting text, phase or sentences and label it into a group. Code usually write up in short and easier to understand. As an example, in Petra Schubert, Susan P. Williams (2012) research, the word Culture is the most code that has been determined. All interview manuscript will be going through and highlight any interesting potential codes that may bring any potential to the analysis. After the texts have been analysed, collate all the words and group it together to identify the code. These codes will determine the overview of theme and might shares common meaning with others.

3.6.3 Generate Theme

All the codes that have been collected, group it together in and find similarity to the code to turn it into a theme. Table 6 is an example of codes to group it into

theme. At this stage, researched may decide whether the word is not suitable or not relevant enough and it can be removed.

Table 6: Turning the code into theme

Codes	Theme
Intermittent connection	Infrastructure
Low bandwidth of data	
Hardware requires an upgrade	

3.6.4 Reviewing Theme

Next reviewing the theme to ensure this accurate representation of the data, can be use in write and contribute to the analysis.

3.6.5 Define Theme Name

After the theme has been filtered and reorganize, the final theme name will be firmed up. Researcher will use this theme names to write up the findings and ensure the theme name is relevant to the content of the finding's description. On top of that, researcher might change the theme name with another synonyms word to ensure the write up is easier to read. As an example, "inadequate bandwidth" would be recommended to change to "poor connection"

3.6.6 Write up

Once the themes have confirmed, researcher will start on writing the findings and report. In findings, researchers will decide on which theme contribute to answer all research questions to achieve research objectives. All the themes will be linked up together to create the results. The aim for this writing is to translate all the stories from the interviewee into a comprehend writing. A concise and clear explanation of the story and themes are important for readers to understand what researcher try to explain in the report. The report should contain sufficient information back up with relevant data from journal or academic research.

3.7 Inductive Reasoning

Inductive reasoning is a process in which multiple analysis are combined to obtain a specific conclusion or to supply evidence for the truth of a conclusion (Bruno Sauce and Louis D. Matzel, 2017). Inductive reasoning is often used to generate predictions or to make forecasts. Inductive reasoning will collect the data and spot the pattern. From the pattern the researcher develops a hypothesis will come out with the theory. The result may not always accurate because the theory is never tested yet. It must be supported with the relevant cases and research to ensure the theory works theoretically.

For this research, inductive reasoning needs to be used instead of deductive of reasoning due to there is no existing same theory to be tested. Therefore, an inductive reasoning has been choosing to prepare the explanation or theory.

3.8 The Reason of Choosing Qualitative Research

3.8.1 Sampling

Sampling is the process of selecting units from a large population. It can be by demographic, psychographic and geographic. Sampling can be used to represent the entire people who is involve directly with RFID toll implementation.

In this research, a random sampling has been chosen. 2 people have been choosing to represent each System Integrator to find their method of deploying the project. These people involve directly with the project and experienced with RFID technology. The reason only 2 sampling has chosen is due to unavailability of people to spend their time let being interviewed. As this research involves people directly, researcher needs to find a person that really suits the criteria which is System Implementor that is familiar with RFID Toll concept. On top of that, an incumbent interview with representative from MHA, JPJ, Touch N Go and RFID consultant have been conducted to obtain more information for this and there are not include in random sampling but essential people.

3.8.2 Validity

By using Qualitative Research, data can be validating easily. One of the indications to ensure the research is valid and sound is validity. Once data has been collected, it will need to check whether the data is valid. The reason of validity is to make sure the data collected are reliable, valid and accurate.

Once data has been consolidated, the summary data has been sent back to the resources. The resources, which are the person that has been interviewed will cross checking the data and verify whether the summary is valid.

3.8.3 Case Study

For this method of Case study, it allows researcher to understand and examine the data in detail context. Most of the time, case study methodology selects a minimal geographical area or a very low number of people as the subjects of study. The selected population corresponds to the entire set of subjects who has characteristics that may interest to the researcher. From the results gathered from a sample, researcher would be able to draw their conclusions about the target population with a certain level of confidence, following a process called statistical inference, which is the process of using data analysis to draw conclusions regarding the population or process beyond the existing data (Laura Lee Johnson, Craig B. Borkowf, Pamela A. Shaw, 2012). When the sample contains fewer individuals than the minimum necessary, but the representativeness is preserved, statistical inference may be compromised in terms of precision (prevalence studies) and/or statistical power to detect the associations of interest.[1] On the other hand, samples without representativeness may not be a reliable source to draw conclusions about the reference population (i.e., statistical inference is not deemed possible), even if the sample size reaches the required number of participants. Lack of representativeness can occur as a result of flawed selection procedures (sampling bias) or when the probability of refusal/non-participation in the study is related to the object of research (nonresponse bias). Case study as a research method is using to investigate a real situation phenomenon through detailed contextual

analysis of number of events or conditions, and relationships. Yin Methodology explains that case study research methodology “as an inquiry that investigates a contemporary phenomenon within its actual scenario context; when the boundaries between phenomenon and context are blurred of evident and use multiple sources of evidence (Robert K. Yin book, 2011)

3.8.4 Advantage of Qualitative Methodology

The reason why qualitative research methodology has been chosen instead of quantitative is because researcher needs the feedback from the interviewee. In quantitative method such as questionnaires, the sets of questions are fixed. The respondent cannot express their thoughts and feedback that is out of the questions. In other hand, using qualitative method such as interview, lots of questions can be asked.

Structured questions have been designed to ensure the respondent could explain and elaborate the questions given based on their understanding of the research topics so that the data collected can be used to verify trustworthiness. During designing the questions, researcher targeted all the parties that involve in electronic toll collection system to understand the existing situation and technology to see if there is any gap to adapt the RFID concept. As most of the targeted sampling is involve directly with RFID implementation, researcher will have better explanation from the right subject on the existing issue happening. From the explanation be given from the interviwees, researcher would be able to obtain the feedback on what should be improved in order to ensure RFID implementation is up to the international standard.

The other purpose of performing qualitative method such as interview is to gain a clear understanding. By using interview, researcher can gain participant insight, understanding and help subject to aware of the issues that could influence them.

Although there are sets of structured question will be questioned, somehow the interviewee can express their thoughts and opinions outside of the questions. There might be some other information that researcher can capture during the interview that might have not been think about it before. This additional information might be useful for the researcher. The interviewee may feedback to the researcher things that personally happen to themselves when about what has been encounter with this technology.

3.8.5 Data Collection Process

A figure 17 shows the process on how data will be collected. Semi structure questions will be prepared to interview the respondent. The reason semi structured question will be used instead of structured is because researcher needs the feedback and opinion from the respondent. Next researcher will select the relevant subject (people) and conduct the interview. Once the interview is done, the data will be analysed to conclude the findings.

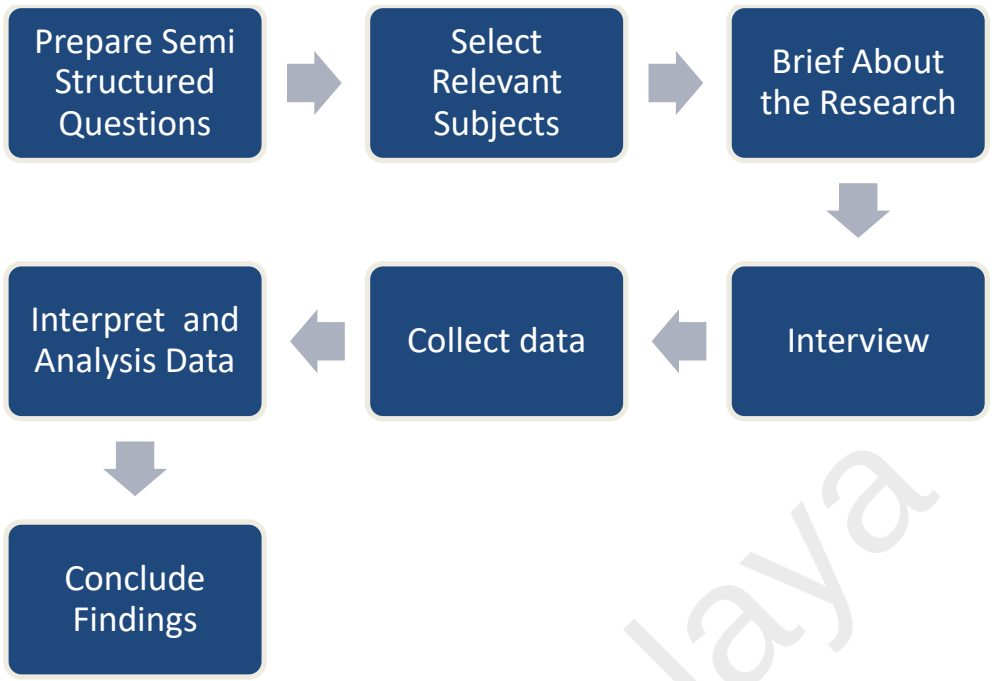

Figure 17: How data will be collected processes (Adams, William. 2015)

3.9 Summary

This chapter highlights the research design and approach where a study framework is developed and then evaluated to finalize for execution. The research methods were also identified based on the objectives of the relevant research stage and their sequencing was described in the research design. The research scope was overviewed, entailing the focus on specific or related department within the airport and airlines in Malaysia. The research process was initiated with a literature overview and followed by interviews. Several department representatives to be interviewed were conducted to gather the information related to the research objectives and questions. As a result, findings on proper planning stressing out on scope, quality and stakeholders will be used as a guidance to improve the implementation of RFID toll in Malaysia.

During this research, 8 persons have been interviewed to collect the data for the findings. The sampling from the population was chosen due to direct involvement with the RFID Toll in Malaysia. From all the parties that involve directly with this project, 1 or 2 person from the entities are selected base on their expertise on this project.

4 CHAPTER 4: DATA COLLECTION AND ANALYSIS

4.1 Data analysis and result

4.2 Introduction

In this chapter, the results of the details of the interview are presented. The details were processed in order to in response to the problems described in chapter one. The finding which presented in this chapter will show the needs for this research conducted. The semi structure questions that had been designed are using qualitative research. All questionnaires derived from the student case study that has been highlighted in the chapter one. On top of that, since there was no proven theory to test, researcher leveraged on discussion in Chapter 2 to combine with the result. At the end of this chapter, the reliability and validity of the research will be discussed.

4.3 Research strategy

The findings from the study were used as the guideline to identify the answers for the research questions that been highlighted in the Chapter 1. The results are presented as follows according to the theme. The research strategy consists of an interview with the parties that involved directly of implementing RFID for toll in Malaysia. The selection of interviewees is based on the person of being involve in this project since it was commencement.

5 sessions of interview were held face to face and audio conference between researcher and Touch N Go, TERAS, FETC, JPJ and MHA. The question is open-

ended so that the interviewees could express and elaborate their thoughts regarding this project. Each of them was from different parties and roles. With the result from the interviewers, researcher is comparing and use cases in Chapter 2 to come with the hypothesis of this research.

4.4 Questionnaires

A set of 8 questions have asked to the 8 peoples from different companies to obtain the feedback and data. These questions were designed for the purpose of the understanding the existing toll operations in Malaysia, determine the root cause of the RFID toll issue in Malaysia and obtain a direct feedback and suggestion from the parties for any improvement of RFID toll in Malaysia. A particular for the interviewees and the reason for the questions were asked is shown in table 7. All of the interviewees are involving in RFID for toll project directly and the feedback are coming from their experience and observation during the involvement in this project. As an example, TERAS can explain the whole operations for PLUS highway, TNG and MHA will give better overview on the implementation of RFID toll and FETC will advise on the improvement for RFID toll in Malaysia after seeing all the issues happening to achieve internationally standard like Taiwan.

Table 7: Interview question for MHAS, TERAS, Touch N' Go, FETC and JPJ and the purpose.

Question for each party that involve in RFID toll in Malaysia	**Reason for Questions**
Question 1	The question was asked to know who is this parties that involve in implementing RFID for toll in Malaysia.
Question 2	The question was asked to know how they involved in this project at the first place.
Question 3	The question was asked to know what is their scope in this project.
Question 4	The question was asked to know why the location being selected.
Question 5	The question was asked to know why they have been selected to carry out the work.
Question 6	The question was asked to know during which phase they involve in implementation of RFID toll in Malaysia.
Question 7	The question was asked to understand the existing toll operations in Malaysia and root cause of issue has been occurred for RFID for toll in Malaysia.
Question 8	The question was asked to know if there any feedback if they could have done better and recommend any improvement for RFID toll in Malaysia.

Table 8: The particulars of the interviewees

Interviewees	Gender	Designation	Involvement in RFID Toll
R1	Female	Touch N Go – Project Manager	Yes
R2	Male	Touch N Go – Project Manager	Yes
R3	Male	MHA – Technical Team	Yes
R4	Male	TERAS – Region Head Johor	Yes
R5	Male	FETC – Project Manager	Yes
R6	Female	FETC – Account Manager	Yes
R7	Male	JPJ – Enforcement	Yes
R8	Male	JPJ – Licensing	Yes

4.5 Interview Output

4.5.1 Scope – Touch N Go ewallet as a payment method

Rolling out RFID toll in Malaysia is an initiative from Touch N Go (TNG) Malaysia and approved by Malaysian Highway Authority (MHA). TNG is the key company responsible to ensure all the toll is enabling RFID at their toll booth. MHA is responsible to oversee and govern the implementation of RFID toll in Malaysia as it involves multiple toll concessionaires. TNG being a single ETC ewallet is the successful factor in this project to make the solution seamless. The just required single testing from ewallet to integrate with all the system.

4.6 Deficiency with TNG ewallet Apps

TNG ewallet has successfully deploy and release to public to use. TNG ewallet has no issue to reload with multiple payment method and provide real-time balance. Somehow, the integration with TNG physical card into ewallet to view the status balance of card is deficiency. This is the flaw with this ewallet that researcher can observed from the research.

4.6.1 Scope – Different RFID concept between Taiwan and Malaysia

MHA appointed FETC as a consultant to provide guidance due to their experience with MLFF in Taiwan. The concept RFID toll in Taiwan is different with Malaysia. As in Taiwan, the project governs by their MOT to oversee overall of the project.

In Taiwan only single SI is managing all tolls booth in Taiwan, which is FETC. FETC is responsible for the Taiwan freeway ETC total solution, including front-end and back-end systems as well as business model, from planning, designing, building, testing, and operation. It is easier their MOT them to manage the project with lesser interruption from other stakeholders.

In Taiwan, their ewallet majorly use for virtual payment only, unlike Malaysia our TNG ewallet is linked with physical TNG card. TNG card will use credit inside linked ewallet as default method for deduction of toll payment. If there is insufficient credit in ewallet, it will deduct the balance from the physical card. As a result, it looks

impressive with dual options method. Unfortunately, the balance for physical card is not update real-time and update every 24 hours and sometimes more than that. This is difficult for the user to check the balance in TNG physical card to pay toll for PLUS as PLUS has not activated the RFID and ewallet integration yet.

RFID toll in Taiwan has used secondary detection to make sure their RFID solution works efficiently. They are using Automated Number Plate Recognition Camera (ANPR Camera) to scan the plate number of the vehicle in case the RFID tag can not be detected. For RFID toll in Malaysia, they only rely on RFID reader to read the RFID tag to retrieve the information and toll payment.

4.6.2 Quality – Experienced consultant appointed by MHA

MHA appointed FETC as consultant to this work together with TNG for RFID Toll project. FETC is an experience company who develop the RFID system toll in Taiwan, the only SI managing all tolls operation in Taiwan and having 10 years of experience in ETC and RFID solution. This is one of the key success factors for RFID Toll in Malaysia. FETC has done end to end implementation of RFID for toll in Taiwan and encountered many issues throughout their project. Their experience and solution are precious for Malaysia to ensure we do not repeat the same issue as they have made. On top of that, we could improve things to be better than Taiwan solution as technology now has evolved in the past 5 years.

4.6.3 Quality – Infrastructure limitation from PLUS

As per feedback from TERAS during interview, researcher understand PLUS is having constraints to implement at all their tolls because some of infrastructures, especially in remote areas the connectivity are not stable enough to cater this new system implementation. PLUS has a plan has been drafted and some of it has been executed to upgrade their infrastructure at plaza tolls. With all the infrastructure upgraded, TERAS can foresee the cases issue with tag can not be detected we be lowered.

4.6.4 Quality – Tag quality

TNG might obtained the low quality of RFID tag and inexperience in managing RFID technology. FETC has been appointed as a technical consultant to this project to replicate the RFID concept they have done in Taiwan and advise on this technology base on their experience. Tag quality issue has been highlighted as one of the critical issues in this project. The consistency of tag is doubtful as some of RFID tag performed well and some of it shows poor performance. On top of that, the 512bits RFID tag is doubtful can be used in future for expansion due to limitation of its size.

4.6.5 Quality – Data transaction missing

Transaction sometimes lose in between. From toll, it should send to HQ and send to TNG. Out of 10 transactions, 9 has been captured by TNG system but 1 is missing from TNG system. This require additional work from support team to retrieve where is the breakdown of the connection and wasting of time.

4.6.6 Quality – Involvement of FETC consultant after Go-Live

FETC only appointed as a consultant for Phase 1 of the project (current implementation phase). For Phase 2 (migration strategy to MLFF) and Phase 3 (tender document preparation) are still in negotiation phase.

4.6.7 Project Management Office – Project governance feedback

MHA has been appointed to oversee the implementation of RFID project and provide the guideline to all toll concessionaires. Governance is an important element in project. There should be a strong body to govern this implementation of RFID for toll in Malaysia. Ministry of Transportation should be the one to govern and oversee the project and provide the direction. This will make the project much easier to control because the ministry has absolute advantages to obtain any data from other agencies, established the process and escalate efficiently for any issue.

4.6.8 Stakeholder – Involvement of PLUS in RFID toll project

PLUS was involved in RFID for toll project since 2017 with JPJ VEP project. PLUS involvement was at plaza toll at Custom, Immigration and Quarantine (CIQ) Kompleks Sultan Abu Bakar (KSAB) at Johor for exit from Malaysia to Singapore. They together with MRCB has embarked as a pioneer to enable RFID function for toll payment back since 2017.

As TNG wishes to enable all toll in Malaysia with RFID, PLUS has decided to launch their own RFID tag and call of their involvement with MLFF project with TNG.

As a result, CIMB (a major stakeholder for TNG) has bring PLUS to undergo arbitration as they believed PLUS has breached the Joint Venture Agreement (JVA) between CIMB, CIMB S1 and PLUS back in 1998. PLUS has agreed to discontinued their plan to launch their own RFID tag and started involvement with TNG MLFF RFID for toll in Q3 2019.

As involvement of PLUS came a bit later, few of the requirements to integrate with PLUS systems need to be gathered to ensure the objectives of this project sync with all of the stakeholders. PLUS has started their RFID for toll testing on early 2020 for all their closed system tolls and target to be completed by July 2020 before customers can start using RFID as the toll payment.

4.6.9 Stakeholder – JPJ's involvement in RFID for toll

Once RFID toll has turned into MLFF concept, JPJ needs to be responsible to enforcement work to those who did not pay the toll. JPJ has rolled out the VEP RFID project and they have experienced on the system, behaviour and data required for RFID toll. Apparently, they did not involve directly with this project and this bring difficulty to TNG and MHA team to obtain data from the vehicle owner for the testing. By having MOT as the leader, data will be easier to be obtained because its related to government project. JPJ is reluctant to provide full data and cooperation to TNG for this project since this data belongs to the government and highly sensitive.

4.6.10 Stakeholder – mha managing all stakeholders

MHA has successfully gathered all the SI and Stakeholders to commit and involve in this testing. Although some of them are facing difficulty to follow the timeline and requirement, they tried to complete the project within minimal acceptance criteria. Managing multiple SI with different operation rules are challenging because that is beyond MHA capability.

4.7 Type of important planning elements

Table 9: Codes with Theme segregation

Codes	Theme
Touch N Go ewallet as a single payment method makes RFID for toll implementation successful	Scope Planning
Deficiency with TNG ewallet Apps make it imperfect	
Different RFID concept between Taiwan and Malaysia	
Experienced consultant has been appointed by MHA to ensure RFID toll in Malaysia following the successful implementation as Taiwan.	Quality Planning
Infrastructure limitation from PLUS has make RFID toll for closed system delay from the go-live date	
Poor tag quality has resulted inconsistency performance for RFID for toll system	
Data transaction missing	

Exclusion support from FETC after go-live may risk the quality of RFID toll in Malaysia	
Involvement of PLUS in RFID toll project at later phase has resulted the RFID system imperfect	Stakeholders Planning
Not include JPJ in this project may impact the system in future	
Managing stakeholders efficiently is the key of successful or implementation of RFID toll in Malaysia.	

Based on the analysis in table 9, it showed the codes and themes of the impact for different area of planning. 4 themes that bring huge significant to the planning of implementation of RFID toll in Malaysia are:

- Scope Planning
- Quality Planning
- Stakeholders

There are 2 criteria that bring positive and negative impact to RFID toll implementation in term of scope planning. The concept of using TNG ewallet apps as a payment method to pay the toll bring the positive impact to the project. This is clearly that scope of this project to make convenience payment method is succeeded. The negative impact to the improper scope planning that makes TNG ewallet failed to provide real time balance enquiry for the physical that has been added into ewallet apps.

Initial plan is to replicate the successful solution that has been implemented by FETC (consultant for Taiwan RFID toll) and use it for Malaysia RFID toll. Unfortunately, the different RFID concept between Taiwan and Malaysia has limit the capability of the system to go on full force to follow exactly as Taiwan concept. Somehow, the experience from FETC has make RFID Malaysia successfully implemented although it was not as good as Taiwan RFID toll.

Infrastructure limitation from PLUS has make RFID toll for closed system delay from the go-live date. All toll are enabling RFID for their toll plaza especially for Open system toll. But due to PLUS delay to implement it for their all Closed system toll, the system was not fully rolled out to the public.

RFID tag for Malaysia always had an issue with tag can not be detected to make the payment. This might due to quality of RFID tag that has been supplied by TNG for this project may has poor quality and impact the performance.

As all the transaction must submitted to TNG by the end of the day, some of the data is missing in between. This is one of the critical issues that needs to be troubleshoot and taking much time to retrieve where is the lacking for this system.

After the project go-live, involvement from FETC consultant is still in negotiation phase. They are proposing to involve in the next phase of RFID implementation on readiness of migration of the system and enforcement of RFID toll. This might risk the quality of the system after all if the expertise experience can only be utilized half way.

Involvement of PLUS in RFID toll project at later phase has resulted the RFID system imperfect. Since PLUS has intention to roll out their own RFID tag for PLUS user, they did not involve in the testing with TNG RFID toll project since the beginning. After arbitration has been completed, then they decided to involve in this project and resulted a delay for full roll out for RFID toll project.

JPJ is responsible to perform enforcement once the project has migrated into the new system on later phase. JPJ were not engaged to involve in any testing with this project. Even though they have implemented it back in 2017, their experience on RFID toll in Malaysia was not counted.

Managing all the SI for this project is the key of successful for this project. MHA has well managed all the SI and toll concessionaires to commit into this project. This is one of the key factors that makes this project successful.

4.8 Conclusion from the interviews

The interview that has been conducted are majorly to understand the existing toll operation works in Malaysia, understand the root cause of the issue and obtain suggestion for improvement RFID toll in Malaysia. From the interview with TERAS, an idea on how toll operation works in Malaysia become clearer. TERAS also highlighted the initial plan for PLUS and reason behind PLUS was strayed away from the project and join back in 2018. FETC as the expertise in Taiwan RFID toll, who is involved in RFID project Malaysia to explaining the issue of RFID toll in Malaysia base on their experience involved Malaysia's project and Taiwan. As an expertise in

this area, FETC highlighting some of the issue was occurred during pilot testing in Taiwan is happening to RFID toll for Malaysia as well. They have found out the solution few years back and suggested an improvement to Malaysia RFID toll.

5 CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter will present the findings of this project paper and attend to all research objectives and questions set in the previous chapter. Also, this chapter will discuss the limitation of the study and recommendation for future further research. In this chapter, the result of data from the interview from findings will be compared and combined with supporting from literature review cases to develop the theory of inductive reasoning.

From the theory developed, researcher can prove the objectives whether it is sync from the hypothesis or not. The hypothesis consists of elements of planning for scope, quality and stakeholder. A literature review will be used to compare the findings for this research.

5.2 Discussion on the aim

This project paper attempts to identify a solution to improve project implementation for RFID toll in Malaysia, 3 main components are identified and related to each. With the better understanding of existing toll operations in Malaysia, the reasons why some of the toll concessionaires unable to perform well could be determined. With the issue has been highlighted for RFID toll in Malaysia, a proper solution could be suggested to fix the root cause of these issues happening. On the

other side, having FETC as MHA's ETC consultant could bring up the standard of RFID toll in Malaysia as seamless as Taiwan's ETC.

5.3 Research results compare with literature review

Base on the research input, there are few elements of gaps RFID for toll in Malaysia could do to improve the implementation processes.

5.3.1 Discussion on the implementation for toll governance

RFID toll for Malaysia is leading and govern by MHA an agency which is a statutory body under Ministry of Work Malaysia to monitor the works and administration of expressway. While other countries such as Taiwan is leading and monitor by Freeway Bureau (under Ministry of Transportation and Communication Taiwan) and implement by FETC, specialize with RFID toll implementation. Brazil is leading by DENATRAN, linked with Ministry of Cities which is to oversee and enforce traffic laws and regulations. Turkey is leading by General Directorate of Highways (KGM) which is a state agency in charge of the construction and maintenance of all public roadways outside of cities and towns in Turkey under Ministry of Transportation and Communication Turkey. And finally, Singapore is leading by Land Transport Authority a body under Ministry of Transport Singapore.

Compared to all successful countries, all agency are related to Ministry of Transportation for effective project governance while Malaysia is leading by agency of Ministry of Work to monitor work and administration of expressway only.

5.3.2 Discussion on the secondary detection for RFID solution

RFID toll in Malaysia only have the RFID reader itself. Standard method for other countries they have secondary detection to detect any vehicle that does not have RFID tag or failure to pay the toll. In other countries, the RFID solution paired with secondary Automated Number Plate Recognition (ANPR) camera to capture the vehicle plate number in any case their RFID tag was failed to read.

With this, it could still capture the vehicle passing by the toll with the failure of detection of RFID tag. In JPJ VEP RFID project Malaysia, JPJ was occupied with RFID reader and ANPR camera to recognize the vehicle origin country whether from Malaysia or foreign country. With this method, vehicle still be able to passing through the toll nevertheless the RFID tag was failed to read.

5.3.3 Discussion on the new technology campaign

During implementation of RFID toll, there is no sufficient campaign has been launch to introduce new payment method using RFID to the public. There was no advertisement on media such as television and radio. In Singapore, there was a pilot testing for 3 months to introduce the new payment method for toll. Singapore has charged zero dollars to the vehicle that passing through their toll for 3 months and expect a feedback from the consumer to report any issue, fix the bugs, installation of the IU device, replacement of faulty IU device and any improvement to the system. Singapore LTA is launching a massive public campaign to the motorist to educate

them on the new payment method such as a banners, pamphlets and advertisement on the media.

This method should be adapted for RFID toll in Malaysia for better customer engagement. With this, public would be able to raise their concern on the RFID issue, replacing if the RFID tag faulty and feedback on the improvement of the toll itself.

5.3.4 Discussion on lack of enforcement from authority for unpaid toll

For any vehicle in Malaysia who failed to pay for the toll, it does not have any enforcement from the authority. In Taiwan, if any vehicle has insufficient balance in their eTAG they will need to pay within 25 days or else, a fine of NT300 per day will be imposed to the vehicle owner. Same goes with Turkey they imposed a fine if it is not paid within 15 days and Singapore will be given 14 days to pay the toll or $10 fine a day will be imposed to the motorist.

In RFID toll for Malaysia, an enforcer (JPJ) should be invited to any project meetings and discussion to keep them updated on the progress of project and discuss on the enforcement plan to those who did not pay for the toll. JPJ would highlight their concerns and needs on how to develop a proper enforcement model with RFID technology once the toll starts the enforcement to the traffickers later.

5.3.5 Discussion on the inadequate practice with PMBOK project stakeholders management practice

In project level as per Project Management Body of Knowledge's guideline, stakeholders management is important to ensure all stakeholders are being identified in initiation phase, plan stakeholder engagement to get their attention and expectation align with the project objective, managing stakeholder closely to communicate if any issue should be addressed and monitor stakeholder engagement if any modification or changes require from the stakeholders. In this research, PLUS was identified as one of the stakeholders for RFID toll project. PLUS has been engaged during project planning phase brief of the scope, align the expectation and gather any potential impact. During execution phase PLUS decided to pulled out from the project and wants to develop their own RFID solution for PLUS highway.

5.4 Conclusion

Many elements that may bring impact to RFID toll in Malaysia. It was started with the better understanding whether the existing technology for Malaysia's toll is ready for RFID toll or not. This research mainly about to identify a solution to improve project implementation for Malaysia's RFID toll project. From the result of the findings and cases study with other successful countries, Malaysia is still lacking of few important elements. There is no big restriction for Malaysia to improve the current RFID toll to become superior like Taiwan, it just lack of epitome model to replicate towards internationally standard.

6 CONCLUSION AND RECOMMENDATION

6.1 Introduction

The work presented in this thesis was conducted with the focus to tackle the specific objectives which were established in Chapter 1. Therefore, the conclusions of this thesis are organised in three sections based on each of the objectives together with the recommendations.

6.1.1 Objective 1

To analyse existing toll operations to use RFID toll collection systems in Malaysia

Analysis from the academic literature has revealed most of the countries successful implemented RFID toll nowadays are implemented by single System Integrator (SI). With single SI, a standardize system could be implemented across all the tolls nationwide. With Malaysia consisting of more than 10 SI, it is difficult to ensure all SI are compliance with the project requirements. Some of the SI are having 4 toll lanes and some are them are having 10 lanes, which makes better options to dedicate single lane for single payment method (TNG Card, Smart Tag and RFID) and not to combine with other payment method.

Technical specification document that consist of infrastructure requirement has been distributed to all parties. Sadly, there are some toll plaza that located in countryside is not be able to perform as per required requirement. Few of the tolls are

located in countryside facing limitation of internet bandwidth. Leveraging on wireless connectivity instead of fix internet line may causes the delay of transaction back to MHA's system and intermittent connection that leads to uncaptured transaction. FETC highlighted ETC requires high bandwidth to perform smoothly without delay as all the transactions should be happening in less second. TERAS mentioned they are in the middle of upgrading the infrastructure to support this solution for better performance in future.

6.1.2 Objective 2

To determine the issues of existing RFID system toll collection in Malaysia.

One of the factor affecting the performance of RFID toll in Malaysia is quality of the RFID tag. In academic literature from Taiwan, none of this issue highlighted during implementation of the project. Assuming this, low tag quality issue is small percentage of issue happening worldwide but somehow, it happened in Malaysia. A tag performance review should be conducted with the few sampling to test each batch of tag has arrived to Malaysia to ensure issue with tag quality will not become serious.

As FETC is an expert in implementation of RFID toll in Taiwan and MHA's consultant, they were not involved with RFID toll Malaysia project once the project has launch. As a consultant, they should be involve during this phase to support the system at least for few months until the system is stable.

From the interview findings, only a single payment method using TNG ewallet are allowed. This payment method has been firmed up since the beginning. Although PLUS was trying to get their RFID tag launch to compete with TNG. From the LR, PMI has highlighted one of the key elements for successful project factor is to develop scope management plan and documented all the agreed scope. With this, only TNG ewallet will be used for all toll RFID toll in Malaysia and did not support any other method. TNG and MHA have strongly stand on this managed to get PLUS involved again in this project on later phase in 2018.

With no other options for online toll payment, TNG ewallet is having issue to integrate it with physical card to view in real time balance of physical card. This is one of the missed-out planning that needs to be improved by TNG to ensure all the scope has planned completed according to the agreed manners. This may due to improper defining the scope in detail (PMI) on what should be completed by the end of the project and what should be exclude.

Same system concept has been agreed and planned to roll out the project according to FETC's consultation for this project. TNG should be working towards what have been planned to follow Taiwan's RFID concept. Unfortunately, to integrate TNG physical card with ewallet has makes this project completely different from what it should be.

6.1.3 Objective 3

To recommend RFID toll system improvement in Malaysia up to internationally accepted standard

As third objective is the main objective of the conclusion for this research, there are few recommendations can be proposed to improve implementation of RFID toll in Malaysia. In final objective, it concludes the aim of the research is to identify a solution to improve project implementation for Malaysia's RFID toll project. 5 proposed solution have been identified to improve RFID toll Malaysia up to internationally standard such as firming the project scope, fully utilize FETC as the expert in RFID solution, suggestion project lead by MOT instead of MHA, replicate the RFID concept from successful countries and proper stakeholders management.

6.1.3.1 Firming the project scope

Firming the scope of the project is important. Project will be delayed if the scope is not firm up. This will lead to scope crepe that will result increase cost, delay timeline and poor quality of work. Communication is important in all project to ensure all the information, updates and issue can be pass to all the relevant parties. Inefficient communication will affect the project as people is working with high uncertainty information. As communication once of the critical factor for project management, stakeholder needs to be updated frequently and with also using efficient communication skills. In here we can see the integration cause and effect if one of these important elements are not take up in seriously.

6.1.3.2 Utilize FETC as the expertise in RFID ETC

As FETC is the important agency to implement the RFID toll in Taiwan, a knowledge transfer and recommendation for the RFID system from FETC should be followed. They have faced multiple issue and managed to overcome each one of it to improve RFID toll in Taiwan. This experience useful for Malaysia to ensure the project would not facing the same issue as Taiwan previously.

6.1.3.3 Suggestion project leading by Ministry of Transportation for efficient project governance

In the academic literature, most of the countries implemented RFID toll projects were leading by Ministry of Transportation or agency related to it. With RFID toll in Malaysia is leading by agency under Ministry of Work, the governance of the project is inefficient. With the project supervised by higher authority from related agency, all the issues can be escalated faster for a solution. In this case TNG requires customer data from JPJ for driver's details. As this is a sensitive data, the data was rejected to release to TNG due to security reason and not related to government.

For JPJ, they have doubts on how they should perform enforcement after this project has fully migrated from old system to new RFID system. For the people did not pay the toll, JPJ will be the one who take action to the traffickers. JPJ should be included in this project and keep them engaged although they did not have much interest to involve directly with this project. But with the Ministry of Transportation orders, they should participate this project without any reason.

6.1.3.4 Replicate RFID implementation method from successful countries

Malaysia implemented RFID toll slightly different from other countries. This is due to few limitation to our existing system environment. TNG ewallet should be able to integrate with TNG physical card for user that want to use physical card for toll payment. This is for PLUS closed toll payment.

TNG ewallet should be able to update the balance in TNG physical card in real time. Currently the balance will be update within 24 hours from the last transaction of card payment.

Secondary system such as ANPR should be introduced to read the car license plate number in case the RFID reader failed to read RFID tag for toll payment. With this method, the barrier gate should be opened without waiting the respond from back end system to deduct the balance from RFID tag. The payment can be deducted later as the plate number has been captured during failure of reading RFID tag. This is important to ensure to traffic jam at the toll if the barrier gate did not open due to failure of reading RFID tag.

6.1.3.5 Proper stakeholder management

The project was carried on without solving the stakeholder issues with PLUS as PLUS decided to move out from the project to launch their own RFID tag for their toll user. The project was completed without PLUS involvement before they decided to get involve again in 2018. The project considered partially completed without PLUS

in 2019 as it impacted the consumer using PLUS highway without the ability to use RFID tag and ewallet. PLUS should be keep on this project from the beginning throughout the project to avoid the delay and smooth project implementation.

6.2 Proposed Future Work

This research can be further investigation is deemed necessary to complement the conclusion obtained from the current work. The following proposition is made for future work:

1. Capability of TNG RFID Tag to replace Physical Road Tax for vehicle in Malaysia.
2. TNG RFID tag and ewallet for gated parking payment in Malaysia.

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