THE INCORPORATION OF MULTI-LANE FREE FLOW SYSTEM : NEED ANALYSIS AND CHALLENGES

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I hereby declare that all corrections and comments made by the supervisor(s)and examiner have been taken into consideration and rectified accordingly.

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ABSTRACT

The multi-lane free flow (MLFF) is a system that allow highway users pay to drive through free flow without stopping. With MLFF, the toll lanes at toll plazas can be replaced with regular segments of multilane roads. Tags with readers are used with gantries across the highway to detect vehicles and to deduct tolls from vehicles using the Electronic Toll Collection (ETC), Traffic congestion at toll plazas on expressways is a regular condition on transportation networks and happens when more people use the tolled expressway. It is characterized by slower speeds, longer trip times, and more automobiles in queues. An Expressway is supposed to be an alternative for road's user to use to avoid jams and to have faster travel time but due to the inefficient toll's payment system, congestion have occurred on expressways. This study attempts to understand the concept of Multi-Lane Free Flow system to reduce traffic congestion at toll plazas and on Malaysia's expressway as well as to identify the challenges of implementing the system in Malaysia. The data from survey shows that the expressway performance in Malaysia is not satisfactory. This is due the payment system is inefficient and still causes congestion even though there are so many alternatives for payment. This project review various study based on previous research on the design and challenges in implementing MLFF in other countries, interviews's highway concessionaire for deep knowledge of implementing MLFF, analyse the road user's satisfaction with the performance of current toll payment system in Malaysia and their perspective on MLFF system. Based on the findings, the research study shows that MLFF system has proven to be successful in other countries, as it has helped in preventing congestion. The study also shows that the challenges of implementing the MLFF in Malaysia includes the challenges of enforcement and the challenges of having sufficient fund from the government to manage the new technologies such as

RFID. Malaysia's technology is still in relatively behind other countries. The road's infrastructure in Malaysia need to be reformed due to poor design and the new legislation need to be made to avoid leakages from occurring.

ABSTRAK

Aliran bebas berbilang lorong (MLFF) ialah sistem yang membolehkan pengguna lebuh raya membayar untuk memandu melalui aliran bebas tanpa henti. Dengan MLFF, lorong tol di plaza tol boleh digantikan dengan segmen biasa jalan berbilang lorong. Tag dengan pengesan digunakan di gantri untuk merentasi lebuh raya untuk mengesan kenderaan dan untuk memotong tol daripada kenderaan menggunakan Kutipan Tol Elektronik, Kesesakan lalu lintas di plaza tol di lebuh raya adalah keadaan biasa pada rangkaian pengangkutan dan berlaku apabila lebih ramai orang menggunakan tol lebuh raya. Ia dicirikan oleh kelajuan yang lebih perlahan, masa perjalanan yang lebih lama dan lebih banyak kereta dalam baris. Lebuhraya sepatutnya menjadi alternatif kepada pengguna jalan raya untuk mengelak kesesakan dan mempunyai masa perjalanan yang lebih pendek, tetapi disebabkan sistem pembayaran tol yang tidak cekap, kesesakan telah berlaku di lebuh raya. Kajian ini adalah untuk memahami konsep sistem Aliran Bebas Pelbagai Lorong untuk mengurangkan kesesakan lalu lintas di plaza tol dan di lebuh raya Malaysia serta mengenal pasti cabaran pelaksanaan sistem ini di Malaysia. Data daripada tinjauan menunjukkan prestasi lebuh raya di Malaysia adalah tidak memuaskan. Ini berikutan sistem pembayaran yang tidak cekap dan masih menyebabkan kesesakan walaupun terdapat begitu banyak alternatif pembayaran. Projek ini juga meninjau pelbagai kajian berdasarkan kajian lepas mengenai reka bentuk dan cabaran dalam melaksanakan MLFF di negara lain, temu bual syarikat konsesi lebuh raya untuk pengetahuan mendalam tentang pelaksanaan MLFF, menganalisis kepuasan pengguna jalan raya terhadap prestasi sistem pembayaran tol semasa di Malaysia dan perspektif mereka terhadap sistem MLFF. Berdasarkan penemuan, kajian penyelidikan menunjukkan bahawa sistem MLFF telah terbukti berjaya di negara lain, kerana ia telah membantu

dalam mencegah kesesakan. Kajian itu juga menunjukkan bahawa cabaran pelaksanaan MLFF di Malaysia termasuk cabaran penguatkuasaan dan cabaran untuk mempunyai dana yang mencukupi daripada kerajaan untuk mengurus teknologi baharu seperti RFID. Teknologi Malaysia masih berada di belakang negara lain. Infrastruktur jalan raya di Malaysia perlu diperbaharui kerana reka bentuk yang kurang baik dan perundangan baharu perlu dibuat untuk mengelakkan kebocoran daripada berlaku.

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LIST OF ABREVIATIONS

1. Multi-Lane Free Flow (MLFF)
2. Malaysia's Highway Authorities (MHA)
3. Malaysia Institute of Transport (MITRANS)
4. Radio Frequency Identification (RFID)
5. Automatic Number-Plate Recognition (ANPR)
6. PLUS Malaysia Berhad (PMB)
7. New Klang Valley Expressway (NKVE)
8. Touch and Go (TNG)
9. Vehicle-based on-board unit (OBU)
10. Electronic Toll Collection (ETC)
11. Open Road Tolling (ORT)
12. Electronic Road Pricing (ERP)

CHAPTER 1

INTRODUCTION

1.1 Research Background

Multi-lane free flow (MLFF) is a system that enables all highway users to pay tolls while travelling at high speeds in a free-flowing environment. Open road tolling or Multi-Lane Free Flow System is one of the contemporary technologies that is making our life simpler when it comes to the collecting of tolls. Its purpose is to aid in the reduction of traffic congestion during peak hours, due to toll collection. Vehicle classification, video processing, electronic toll collection, and microwave technology are all used in conjunction with Multi-Lane Free Flow to provide a seamless experience.

Every road user in Malaysia may view and experience the toll gate on a regular basis. Other nations are implementing the MLFF system via the use of tags mounted on the windshields of automobiles, which include information that is read by the MLFF reader. Additionally, the MLFF method will increase consumer acceptance by reducing queue time at toll plazas since there is no barrier that will slow down the car before accessing the toll which often cause congestion.

The cost of maintaining and operating the toll collecting system is also far cheaper than it is now. Toll operators at lanes and plazas are not needed with MLFF deployment. In the existing approach, toll operators will handle the collected cash and data at the plaza level. MLFF, on the other hand, will use a back-end purse

system in which toll collection and user account deductions will be managed by Touch and Go (TNG) in the case of Malaysia. The present canopy above the toll plaza will be replaced with a gantry equipped with an antenna for scanning the sticker tag or car plate number. This revolutionary approach eliminates the need for toll plazas (or significantly reduces the size of existing toll plazas), hence lowering construction and operating costs.

1.2 Problem Statement

According to a report published in 2015, traffic delays cost Malaysia's working class 1 million hours of lost time annually. This wasted time leads to annual traffic congestion expenses of RM 10–20 billion (Jerrica, 2021) . Kuala Lumpur's uncontrolled motorization process, expanding population, and limited capacity to increase the supply of physical resources such as roads and parking facilities, particularly in the CBD, may contribute to a situation similar to Bangkok's even though traffic congestion there has not yet reached critical levels. One of the first solutions used in Kuala Lumpur was the development of extra highways and toll expressways. It's important to remember, however, that the strategy didn't succeed in easing Kuala Lumpur's traffic congestion. Several major roads and highways leading into the city center are still congested, especially during rush hour. (KIGGUNDU, 2007). The fact that Touch 'n Go (TnG), the market leader in toll payment concessions, has implemented a new contactless payment system in combination with a dedicated RFID lane does not indicate that this new technology would alleviate traffic congestion especially on peak hours. Congestion occurs as a result of 20-lane toll plazas narrowing to three lanes farther down the roadway.

Even with the most advanced toll technology, such as face recognition, automated number plate recognition (ANPR), passive RFID, inboard active RFID, or microwave or infrared systems, congestion will occur whenever the amount of traffic exceeds the installed capacity of traffic flow. One possibility is to convert automated lanes into barrier-free zones. New legislation has already been developed to increase the penalty for highway toll evaders, including those who tailgate your vehicle as it enters a contactless toll lane (Vong, 2022).

1.3 Objectives

The objectives of this project are :

i. To observe and analyse the present performance of toll plazas in Klang Valley and how it cause congestion.
ii. To review and summarize the challenge of implementation of Multi Lane Free Flow in Malaysia.
iii. To make recommendation of the design of Multi Lane Free Flow system on the highway.

1.4 Scope and limitations of study

The scope of study is to carry out the need analysis and challenges to implement the Multi Lane Free Flow Toll in Malaysia. This study was conducted based on review from previous research study, Then, it is sorted using Microsoft Word in which a table is made to compile the following information which are author, year, research title, research area and findings. This is to ensure that comprehensive literature review study can be conducted. Next, this research focussed on gantry design for Highway's Road and observing tape recorder for traffic flow at chosen toll plaza. The data is obtained from PLUS Malaysia Berhad (PMB). After that, interviewing chosen Highway's concession about the challenge to implement Multi Lane Free Flow (MLFF) and a questionnaire survey for road's user of this study to determine the acceptance of Multi Lane Free Flow (MLFF).

There are some possible limitations in this study. First, only one toll plaza in Klang Valley is used for the research due to less cooperation from Malaysia's Highway Authorities and the concessionaire. The period to require the data will be lengthy due to the procedure needed to request for permission. Less cooperation by Malaysia Highway Authority and the highway concessionaire in giving replies made the process of acquiring data required a long time. The tape video is restricted and personal viewing only allowed in the Plaza Toll, observation and analysis need to do on the same day.

1.5 Significance of Study

To become a developed country, the concept of sustainability must be considered as it is in line with other developed nation in the world. Multi lane free flow system can contribute to overcome the traffic congestion in the future. This research can be used as reference or guidelines for implementation of Multi Lane Free Flow System in the future. Because this technology is gaining greater attention in the community these days, this research is critical in developing innovation for this country. Although this study focuses in Selangor state only, it can be implemented throughout other states or country. Present study can also serve to determine the gap in research in the field of MLFF in Malaysia. Besides that, since MLFF is being tested in Malaysia, the cost of installing this system is much more economical and the expenses such as sticker tag recognition instead of using smart tag and RFID. Consumer can obtain this benefit as Multi Lane Free Flow (MLFF) can reduce travel time during peak hours and ensure a free flow journey. By completely using Multi Lane Free Flow system it will also help to solve air pollution issues that is caused by traffic emission in traffic congestion.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is to introduces the Multi Lane Free Flow System in Malaysia. It discusses previous studies on toll systems, types of toll systems, the concept of Multi-Lane Free Flow System in Malaysia and the design of Multi-Lane Free Flow (MLFF). It goes to identify the design performance and the benefits in the context of social, economy, and environmental before summarising all of the important topics.

2.2 Traffic Congestion Issues In Malaysia

In 2015, a study discovered that working-class Malaysians lose around 1 million hours per year delayed in traffic jams. This lost time equates to RM 10–20 billion in yearly traffic congestion costs. The Philippines is rated first among ASEAN nations in terms of having the worst traffic in the area. The Philippines received 198.84 points in the Traffic Index, while Indonesia received 194.61 points. Thailand is third on the Traffic Index chart, behind Indonesia by 170.6 points. Malaysia ranks fourth with 169.14 points, followed by Singapore 148.61 and Vietnam 111.12 (Jerrica, 2021). Figure 1 shows the traffic index data ranking.

Rank	City	Traffic Index	Time Index (in minutes)	Time Exp. Index	Inefficiency Index	CO_2 Emission Index
1	Manila, Philippines	268.58	56.02	11398.36	288.95	7885.08
2	Jakarta, Indonesia	255.77	53.10	8720.51	289.44	8514.78
3	Bangkok, Thailand	209.38	45.00	3485.06	255.28	7986.02
4	Kuala Lumpur, Malaysia	195.79	41.99	2250.90	208.92	8445.59
5	Singapore, Singapore	147.77	41.18	1975.27	149.12	2492.99
6	Ho Chi Minh City, Vietnam	115.88	31.36	183.94	127.30	3561.29
7	Chiang Mai, Thailand	114.39	25.75	26.21	96.87	5428.17
8	Hanoi, Vietnam	108.72	29.24	80.01	113.25	3588.85

Figure 1 : Traffic index data ranking (Jerrica, 2021)

Congestion on the roads is becoming a worldwide problem, which has a severe impact not just on individuals but also on countries as a whole, particularly in terms of how efficiently and productively they function. In addition to this, traffic congestion is a significant contributor to air pollution because of the significant amount of carbon monoxide that is emitted by each vehicle operating inside the city. As a matter of fact, emissions of carbon dioxide may contribute to air pollution, which is particularly problematic when people are backed up in traffic. The Federal Territory of Kuala Lumpur, Malaysia's most major metropolis, continues to be swamped with newly registered motor cars each year. The Federal Territory's percentage share of newly registered motor cars in Malaysia was 20.88 in 1991, 19.11 in 1993, 19.59 in 1994, 24.24 in 1995, 27.12 in 1996, 28.01 in 1997, 19.13 in 1998, 24.71 in 1999, 24.96 in 2000, 25.08 in 2001, and 26.94 in 2002. Its yearly percentage share fell to 19.13 in 1998, owing to the 1997 Asian financial crisis, which had a negative impact on Malaysian automobile demand (KIGGUNDU, 2007). According to a research that was just released by Index Data, the traffic congestion that occurred during peak hours in Kuala Lumpur during the course of the previous week were even worse than they were in 2019, before the

Covid-19 epidemic. As of the year 2019, the Ministry of Transportation has registered around 31.2 million vehicles, which included motorbikes and commercial vehicles. This was a rise of 3.02 million from the data in 2018, when over 28.8 million cars were registered, and it was in accordance with the pattern of growth in vehicle registrations since 2010. Since 2010, there has been an upward trend in vehicle registrations (Zulkifli, 2022).

According to Kuala Lumpur Traffic Index, in the year 2021, it was observed that the amount of congestion in Kuala Lumpur had significantly decreased. According to the research, the average amount of time spent traveling has fallen by four minutes every day (Tom Tom, 2022). Figure 2 and 3 shows the graph of changes in working days travel pattern from 2019 untill 2021 and the table of weekly traffic congestion by time of day in 2021.

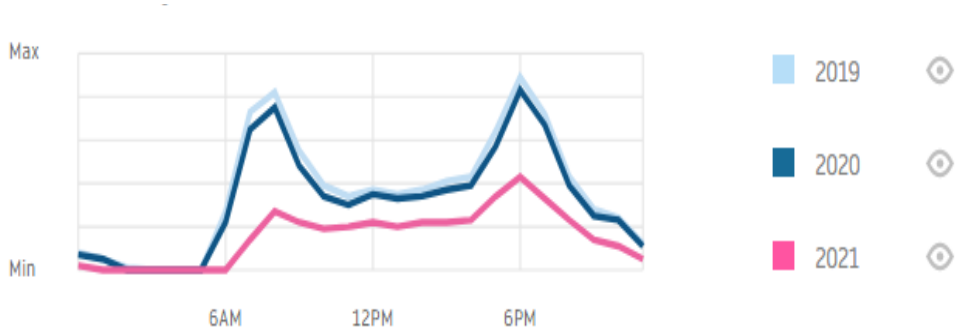

Figure 2 : Changes in working days travel patterns in 2019-2021 (Tom Tom, 2022)

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12:00 AM	4%	0%	0%	0%	0%	1%	2%
	0%	0%	0%	0%	0%	0%	0%
02:00 AM	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%
04:00 AM	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%
06:00 AM	0%	4%	5%	4%	3%	3%	0%
	0%	22%	20%	20%	17%	15%	2%
08:00 AM	3%	32%	28%	29%	25%	23%	7%
	5%	23%	20%	21%	18%	19%	13%
10:00 AM	8%	19%	18%	19%	17%	19%	18%
	11%	19%	18%	19%	18%	20%	23%
12:00 PM	14%	21%	20%	21%	19%	24%	26%
	13%	20%	19%	20%	18%	19%	27%
02:00 PM	14%	20%	20%	20%	18%	19%	26%
	14%	20%	20%	21%	18%	21%	26%
04:00 PM	14%	21%	23%	24%	20%	23%	23%
	16%	35%	37%	39%	32%	38%	24%
06:00 PM	17%	45%	44%	48%	39%	45%	25%
	15%	29%	27%	31%	25%	30%	20%
08:00 PM	13%	14%	16%	17%	13%	17%	17%
	12%	9%	11%	12%	9%	13%	17%
10:00 PM	9%	7%	8%	10%	8%	13%	17%
	3%	2%	3%	4%	2%	6%	10%

Figure 3 : Weekly traffic congestion by time of day in 2021 (Tom Tom, 2022)

Even if there has been a shift in the traffic pattern, the facts show that. Even after all of these years, the flow of traffic is still congested, especially around rush hour. According to the director of the Malaysia Institute of Transport (MITRANS), Widening roads, for example, would only contribute to an increase in the number of private vehicles on the road, which would make the situation even worse, such measures had only a limited impact on the problem of traffic congestion (The Sunday Daily, 2022).

2.3 Malaysia Expressway System

The Malaysian Expressway System is a network of controlled-access national expressways in Malaysia that serves as the principal backbone of the country's national roads. The network starts with the North-South Expressway (NSE), which is currently undergoing significant development. Private enterprises construct expressways in Malaysia under the supervision of the government highway authority, the Malaysian Highway Authority. Malaysia's expressway network is regarded as one of the finest controlled-access expressway networks in Asia, second only to Japan and South Korea. There were 30 expressways in the nation, totaling 748 kilometers in length (465 mi) and a further 219.3 kilometers (136.3 miles) is being built. The closed toll expressway system is comparable to those of Japan and China. All toll expressways in Malaysia are controlled-access highways that are operated under the Build-Operate-Transfer (BOT) system.

2.3.1 Type of Toll Plaza

2.3.1.1 Open Tolls

Toll plazas that operate on an open system will charge tolls based on a predetermined rate that is determined by the kind of vehicle. This has been deployed on most roads in the Klang Valley, and you will be required to pay a toll fee when you drive through a specified length of the roadway. Open toll

methods are used on the vast majority of expressways. The following toll roads are classified as open tolls, as shown in the following table

2.3.1.2 Closed Tolls

Users may either collect toll tickets or use their Touch ‘n Go card to enter the toll booth. North South Expressway issues the PLUS Transit cards, and other closed toll expressways such as the East Coast Expressway and South Klang Valley Expressway issue the transit card before entering the expressway at respective toll plazas and pay an amount of toll or touch out with your same touch n go card at the exit toll plaza plus the distance from the plaza to the Limit of Maintenance Responsibility (LMR) before exiting the expressway at the respective toll plaza. It is calculated how much it will cost to use this system dependent on how far you go.

2.3.2 Type of Toll Payment

Table 1 shows the different between every payment system in Malaysia. Touch and go system, Smart Tag and RFID. Based on the table it shows that RFID is the most efficient system to be used.

Table 1 : Different between toll payment system in Malaysia

Touch'n Go	**SmartTAG**	**MyRFID**
Card with an embedded microchip	An in-vehicle unit	Radio-frequency identification tag (RFID)
Contactless card with antenna	Use infrared transmission	Use microwave transmission (Active & Passive)
Used at dedicated toll lanes with automatic barriers	Used at dedicated toll lanes with automatic barriers	No toll lanes/gates uses a gantry system (not implemented in Malaysia)
Reduced speed at Touch'n Go lanes	Reduces speed at SmartTAG lanes	Faster traveling speed

2.3.2.1 Manual Toll Collection

Manual toll collection system is a system that requires car to stop at the toll plaza. This use cash payment system which now has been disposed in Malaysia. Manual takes too much time as it requires vehicles to stop and pay the toll rates.

2.3.2.2 Touch ‘n Go System

When it comes to toll payments, Touch 'n Go is perhaps the most widely used electronic payment method in Malaysia. Prepaid smart card that operates on the contactless technology platform. The information contained in this card may be read and written via magnetic induction, which is accomplished through the use of specialized radio frequency and smartcard software.

2.3.2.3 SmartTag

SmartTAG is a vehicle-based on-board unit (OBU) device that is used as an electronic toll collection (ETC) system across extended distances (up to 15 metres) to complement Touch 'n Go, which is a card-based system. Malaysian authorities initially employed it as an entrance access security system in 1999, and it has since been widely utilised worldwide.

2.3.2.4 Radio-frequency identification (RFID)

Radio-frequency identification" (RFID) is an abbreviation for "radio-frequency identification," and it refers to a technique in which digital data contained in RFID tags or smart labels is acquired by a reader using radio waves. An RFID tag or label is similar to barcoding in that the data from the tag or label is acquired by a device that then records the information in a

database. RFID, on the other hand, provides a number of benefits over barcode asset tracking software solutions in terms of efficiency. In particular, RFID tag data may be read even when the tag is not directly in front of the reader, while barcodes must be aligned with an optical scanner. At each toll booth, an overhead scanner detects the radio frequency from a TNG RFID Tag and levies the appropriate toll fee. Using the Tag, the user may connect his or her Touch 'n Go eWallet to his or her Touch 'n Go eWallet balance, and the fare will be debited from that amount.

2.4 History of Tolling Plaza in Malaysia

Prior to the middle of the 1970s, when tolls were first implemented on the expressways, the majority of Malaysians traveled across Peninsula Malaysia via federal roadways. The increasing number of vehicles along federal routes, the opening of major ports and airports in Malaysia, and the rising population in major cities and towns in Malaysia are the primary biggest factors behind the construction of new expressways in Malaysia. Other factors, such as economic development, are also contributing factors.

After the expulsion of Singapore from Malaysia on August 9, 1965, the Malaysian government chose to construct Port Swettenham (now known as Port Klang) Malaysia's new national port as a substitute for Singapore. This decision marked the beginning of the history of the highways in the Klang Valley. As a consequence of this, the government devised a plan in the 1960s to construct the first highway in the Klang Valley to be known as the Federal

Route. This highway would link Port Swettenham, which is now known as Port Klang, to Kuala Lumpur. The first dual-carriageway highway in Malaysia, the Federal Highway (also known as Federal Route 2), was opened to traffic in 1967 and stretched for 45 kilometers. Because of the growing size and population of the Klang Valley metropolitan area, the development of new townships and industrial estates, and the massive traffic jams along Federal Highway, the federal government made the decision in the early 1990s to construct additional expressways and highways in the Klang Valley. This decision was made in response to these factors.

2.4.1 Issue highlighted on media expressway in Klang Valley.

Malaysia news article on early 2022 stated the constant buildup of traffic, regardless of time, weather, or road conditions, has been a concern among Klang Valley drivers. Figure 4 shows the vehicles merge in one of Klang Valley expressway during peak hours.

Figure 4 :Vehicles merge at the Sungai Besi highway heading to Salak Selatan in Kuala Lumpur (Mustakim, 2022)

The congestion that was formerly linked with employees leaving the office seems to have expanded to all hours of the day, leaving even the most well-planned vehicles stuck in jams. A new Index Data research indicates that Kuala Lumpur's peak-hour traffic congestion during the past week was much higher than in 2019, before the Covid-19 outbreak (Lye,2022). Figure 5 shows traffic congestion in Klang Valley Daily by Paultan.

Figure 5 :Traffic congestion in Klang Valley Daily (Paultan,2022)

According to news article paultan on 27th May 2022, traffic congestion was not restricted to certain time periods. Congestion in the traffic lanes, which previously only happened during rush hour, is now happening at off-peak times. In social media postings from the previous week, workers complained about the worsening traffic conditions on their way to and from work. They said that the scenario was causing many people to leave for work earlier and return home later, since evening traffic congestion now lingered until 8 p.m. or later, which would eventually damage one's mental health (Lim, 2022).

Free Malaysia Today's news article states that the primary issue with roads in Malaysia, and the Klang Valley in particular, is that the majority of toll highways were constructed in response to private-sector requests. This implies that money development is virtually always the primary objective. When highway firms prioritize toll collection above transportation design, the basics are lost. Transport planning is no longer transparent and environmentally and socially advantageous (FreeMalaysiaToday, 2022). The fact that Touch 'n Go (TnG), the company that controls the majority of the toll payment concessions, has implemented a new contactless payment system in combination with a dedicated RFID lane does not indicate that this new technology will address the problem of traffic congestion. This congestion is brought on by toll plazas that have twenty or more lanes yet only have three lanes farther down the roadway. Even with the most recent toll technology that includes all the bells and whistles, such as facial identification, automatic number plate recognition (ANPR), passive RFID, inboard active RFID, or microwave or infrared systems, there will still be congestion once the volume of traffic exceeds the installed capacity of traffic flow. This is because tolls are used to collect revenue from drivers. (Vong, 2022)

Based on the Sunday daily articles (2022) , It has been shown that building roadways, particularly in metropolitan areas, provides only short respite before traffic congestion returns. To guarantee that all roads have a level of service that is up to par, it is important to take into account the amount of traffic that is already there as well as the demand that is expected to come from the surrounding region (Muttaqin, 2022).

2.5 Problem faced by road users at toll Plaza in Klang Valley.

The purpose of constructing highways is to improve the mobility of the nation instead our road system has not been successful in accomplishing this goal, particularly during times of high traffic congestion. Because cars are required to slow down as they approach the toll, it creates a bottleneck in the flow of traffic. As a result, the flow of traffic is limited. Even though several payment options were offered, the issue persists. Even though it was informed that the system is "automated" and there is no need for a toll collector, the payment system must still stop and wait for the machine to scan the device before the gates raise to allow us through (autonews, 2015). Figure 6 shows congestion at RFID lane when the system being implemented.

Figure 6: congestion at RFID lane (Lye,2022)

According to a statement released by the highway concessionaire, a number of vehicles with insufficient funds attempted to recharge their Touch n' Go eWallet at the boom gates during the morning rush hour between eight mornings and eight ninety-five mornings, causing congestion (Lye, 2022). The government's intervention has resulted in the availability of three payment options which is RFID, TnG card, and SmartTAG. (New Straits Times, 2022). The works ministry has tasked Touch 'n Go with finding a solution to the observed congestion at toll plazas caused by the introduction of the radio frequency identification (RFID) toll collecting system. (chan, 2022). According to the motorist, the existing cashless payment method for national tolls is inefficient and has several faults. The issue was that the RFID lane was not functioning. There was a queue of cars and cash was required. The same goes with another payment system (Therakyatpost, 2022).

2.6 Multi-Lane Free Flow

Open road tolling, also known as Multi-Lane Free Flow System, is one of the current technologies that improves the collecting of tolls. Its purpose is to minimize peak-hour traffic congestion, avoid air and noise pollution, and improve sustainability and earnings growth (Yadav, 2021). Multi-Lane Free-Flow (MLFF) enables highway users to travel past a toll station at high speeds, even while changing lanes, without having to slow down and pay the toll. The Multi-Lane Free Flow system is an advanced solution for Electronic Toll Collection (ETC) that includes deduction, vehicle detection and categorization,

picture collection, license plate recognition, and matching. The present toll booths at toll plazas will be replaced with a standard multi-lane road with toll collection gantries. Tags or On-Board Unit (OBU) and readers at gantry along multilane road portions will be utilized to identify vehicles and deduct tolls utilizing the current ETC system (Quatriz, 2017). Besides tolling on highways, MLFF technology can also be applied to a wide variety of ITS applications such as vehicle monitoring for traffic management and efficient vehicle tax management. Figure 7 shows MLFF gantry.

Figure 7 : Multi-Lane Free flow gantry

The Multi Lane Free Flow tolling system is very effective and time saving. The system will be able to handle far more cars per hour than current toll systems since it will employ a cloud tolling system without toll lanes or gates. In addition, it will be able to reduce fraud by closing the gaps that many traffic users often take advantage of and that the current solutions are unable to close (BussinessToday, 2021)

2.6.1 Multi Lane Free Flow System in Malaysia

Multi-Lane Free Flow (MLFF) ETC system, for example, has been considered by the Malaysian highway authority as a possible alternative. Multi-Lane Free Flow (MLFF) is a completely electronic tolling system that uses an overhead gantry rather than lane barriers to transact the user's toll costs in the most efficient manner possible. Multi-Lane Free-Flow (MLFF) system is an electronic tolling system that is utilized in various expressway networks across the globe, according to Md. Salleh and et.al (2006). Currently, nations such as Australia, the United States, Chile, and Canada are implementing a fully electronic toll payment system on a widespread basis.

In the United States, the Multi-Lane Free Flow (MLFF) is an electronic toll collecting system that provides free flow of traffic on a high-speed toll roadway for all of its customers. When completely completed, the present toll lanes at toll plazas will be replaced by readers at gantries spanning the highway that will identify vehicles and deduct toll using the existing Electronic Toll Collection (ETC) system, replacing the current toll lanes. The Malaysian Highway Authority (MHA) intends to phase in the implementation of the MLFF system on all highways beginning in 2010 in phases (multi-lane free flow, 2014).

In early 2022, it is stated that Malaysia's first ever Multi-Lane Free Flow (MLFF) tolling system Proof of Concept (POC) will be implemented on Malaysian roads by a tech solution provider. The first system will be deployed near Besraya Highway KM5.5 (northbound) and data gathering is anticipated

to begin in early 2022 for three months. The data and insights are important for the eventual implementation on Malaysian roadways, in accordance with the government's plan to improve traffic flow. Improving the state's transportation infrastructure is important to ensuring a highway system free of congestion. Similar systems, such as Japan's ETC and Singapore's ERP, are extensively used in other Asian nations . Green Packet, a tech solution provider said that as part of the agreement, the Malaysian business would contribute money, local knowledge, and fintech payments experience. The data obtained from the Proof of Concept (POC) over the course of three months will be shared with the necessary authorities and stakeholders in order to show and evaluate the system's effectiveness (Bernama, 2021). Based on the tech solution provider the system is anticipated to use a cloud-based tolling system with no toll lanes or gates, and it will be able to handle many more cars per hour than current toll systems. It will also be able to prevent fraud by eliminating the gaps that existing solutions are unable to solve and that are often exploited by a large number of traffic users (Khalid, 2021).

2.7 Multi-Lane Free Flow System in Other Countries.

In Singapore, Multi-Lane Free Flow system (MLFF) which is also known as the Electronic Road Pricing (ERP) system is the principal approach that is used to regulate the flow of traffic. When particular roads are more likely to be congested than at other times, Electronic Road Pricing (ERP) gantries that have been installed in strategic locations will charge drivers a fee to use those routes. The Electronic Road Pricing (ERP) system is an efficient way to increase traffic flow and maintain a consistent flow of traffic on roadways. According to the data, speeds have typically improved when Electronic Road Pricing (ERP) rates have been raised, and the opposite is also true. Without the ERP, the flow of traffic will be less efficient (MOT, 2022). Figure 8 shows ERP system in Singapore.

Figure 8 : ERP system in Singapore

In Japan the Multi-Lane Free Flow system is known as Electronic Toll Collection System (ETC). ETC stands for "Express Toll Collection," and it is a technology that enables drivers to pay tolls on toll roads without having to stop their vehicles. This may be done by putting an ETC card into the ETC in-vehicle device that has been installed in the vehicle in question. Wireless connection between the gadget and an antenna located at the toll booth is available on highways that require drivers to pay to drive. For using the Electronic Toll Collection System, you will need both an ETC card and an ETC in-vehicle device. The ETC card will be used to settle toll accounts, while the ETC in-vehicle device will create a wireless connection. (Expressway, 2022)

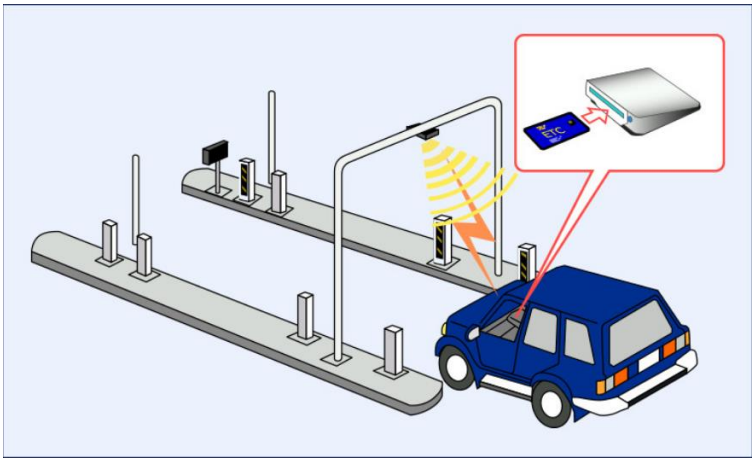

Figure 9: ETC in Japan

Countries such as Australia, Taiwan, Canada, United States and United Kingdom use Open Road Tolling (ORT). The practice of collecting taxes on toll roads without the use of toll booths is referred to as all-electronic tolling, cashless tolling, and free-flow tolling, among other names. In its place, an electronic system for the collecting of tolls is often used. The primary benefit