EVALUATION AND IMPROVEMENT OF ACCESSIBILITY TO URBAN RAIL TRANSIT SYSTEM IN KLANG VALLEY, MALAYSIA

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FACULTY OF ENGINEERING
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ABSTRACT

In Urban Rail Development Plan 2013 and Kuala Lumpur Structure Plan 2020, issue on poor accessibility to rail-based public transport has been highlighted and become the focus in urban transportation planning in Klang Valley, Malaysia. This research aims to evaluate and improve the accessibility from home to urban rail transit system in Klang Valley. The primary data was obtained from N=569 individuals. The sample size for frequent rail users was, N = 335 individuals and for private transport users was N = 234 individuals. The research objective is to investigate the influence of access and travel characteristics scenarios as well as socio-demographic factors on the willingness of frequent rail users/private transport users to travel consistently by rail/private transport and the potential of shifting to private transport/rail transit. The Binomial Logistic Models (BNL) were developed for each travel mode choice preference, namely (1) rail transit and (2) private transport mode with respect to different hypothetical stated preference scenarios. The results revealed that frequent rail users were fairly influenced by access time and access distance increment rather than access cost increment. In addition, frequent rail users were more affected by travel time increment rather than travel cost increment. In addition, the objective of this study is to identify and investigate the current access modes indicators that are priorities for enhancement based on the users' satisfaction and importance level. The Importance-Performance Analysis (IPA) was applied to assess the importance and satisfaction level of rail access indicators offered by different access modes utilities. The findings implied that major improvement works on the disabled persons facilities, safety in the station, walking comfort and access time have to be implemented on current access mode utilities to provide more pleasant travel experiences and simultaneously induce modal shift to rail transit. The suggestion to improve the walking surface for pedestrian accessing the rail transit station was also focused. Through laboratory investigation, the semi-flexible pavement surfacing was

found to be an appropriate alternative as a walkway surfacing material. An evaluation on (i) the rail transit system traits that is of importance and priority to frequent rail users and (ii) the development of structural model for perceived importance of rail transit system through Structural Equation Modelling (SEM) approach are also focused in this study. Based on analysis, the service realibility and safety were discovered as the attributes that should be prioritized in the rail transit system improvement. It was discovered that perceived service quality of rail transit system and rail users travel experience exhibited significant contribution towards the perceived importance of rail transit system traits. Conclusively, in order to ensure frequent users to consistently travel with rail and to encourage occasional rail users and auto-dependent travellers to use rail, improvements on existing rail access and efficient rail transit services is needed. Furthermore, the findings from this study can be contributed in implementing the well-grounded transport policies for both public and private transportation to attain ideal modal shift in Klang Valley and become more liveable urban area in Malaysia.

ABSTRAK

Di dalam Pelan Pembangunan Rel Bandar 2013 dan Pelan Struktur Kuala Lumpur 2020, isu kelemahan akses ke pengangkutan awam berasaskan rel telah diketengahkan dan menjadi fokus di dalam perancangan pengangkutan bandar di Lembah Klang, Malaysia. Kajian ini bermatlamat untuk menilai dan memperbaiki akses daripada rumah ke sistem rel transit bandar di Lembah Klang. Data utama diperolehi daripada *N*=569 individu. Saiz sampel untuk pengguna kerap rel ialah *N* = 335 individu dan saiz sampel untuk pengguna kenderaan persendirian ialah *N* = 234 individu. Objektif kajian ialah untuk menyiasat pengaruh senario akses dan ciri-ciri perjalanan serta faktor-faktor sosio-ekonomi ke atas kecenderungan pengguna kerap rel/ pengguna kenderaan persendirian untuk terus konsisten menggunakan rel/kenderaan persendirian dan potensi untuk mereka beralih ke kenderaan persendirian/rel. Model Regresi Logistik Binomial (BNL) telah dibangunkan untuk setiap pilihan mod perjalanan yang lebih digemari, iaitu (1) mod rel transit, (2) mod kenderaan persendirian berdasarkan hipotetikal "stated preference" yang berbeza. Keputusan menunjukkan bahawa pengguna kerap rail adalah secara seimbangnya lebih dipengaruhi oleh peningkatan masa akses dan jarak akses berbanding peningkatan kos akses. Selain itu, pengguna kerap rail lebih dipengaruhi dengan peningkatan masa perjalanan berbanding peningkatan kos perjalanan. Sebagai tambahan, Objektif kajian ini ialah untuk mengenal pasti dan menyiasat indikator-indikator mod akses semasa yang menjadi keutamaan untuk penambah baikan berdasarkan aras kepuasan dan kepentingan pengguna. Analisis Kepentingan-Prestasi (IPA) telah diaplikasikan untuk menilai kepentingan elemen-elemen kualiti perkhidmatan dan menaksir tahap kepuasan yang ditawarkan melalui pengunaan mod akses yang berbeza. Hasil dapatan menunjukkan kerja-kerja penambah baikan yang menjadi keutamaan ialah kemudahan untuk orang kelainan upaya, keselamatan di stesen, keselesaan pejalan kaki dan masa akses hendaklah dilaksanakan ke atas kemudahan mod akses semasa supaya

dapat memberikan pengalaman perjalanan yang lebih menyeronokkan serta menggalakkan peralihan mod ke rel transit. Cadangan untuk meningkatkan kualiti permukaan laluan pejalan kaki yang mengakses stesen rel transit turut difokuskan. Melalui penyiasatan makmal, permukaan turapan separa fleksibel didapati sesuai sebagai material permukaan laluan pejalan kaki. Penilaian ke atas (i) elemen-elemen sistem rel transit yang penting dan menjadi keutamaan pengguna kerap rel transit dan (ii) pembangunan model struktural bagi anggapan kepentingan sistem rel transit menggunakan kaedah Permodelan Persamaan Struktural (SEM) juga menjadi focus dalam kajian ini. Berdasarkan analisis, kebolehpercayaan terhadap perkhidmatan dan keselamatan adalah element-elemen yang harus diutamakan di dalam penambah baikan sistem rel transit. Secara jelasnya, anggapan kualiti sistem rail transit dan pengalaman perjalanan menggunakan rel telah menunjukkan sumbangan yang signifikan ke atas anggapan kepentingan ciri-ciri sistem rel transit. Secara kesimpulannya, untuk memastikan pengguna kerap rel konsisten menggunakan rel dan untuk menggalakkan pengguna sekali-sekala rel dan pengguna kenderaan persendirian menggunakan rel, beberapa peningkatan ke atas akses rel sedia ada dan sistem perkhidmatan rel transit yang efisien diperlukan. Tambahan pula, hasil dapatan daripada kajian ini boleh menyumbang di dalam pelaksanaan polisi pengangkutan yang mantap bagi kedua-dua pengangkutan awam dan persendirian untuk mencapai pembahagian mod yang ideal di Lembah Klang sebagai bandar berdayahuni di Malaysia.

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Suhana Koting, 2017.

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LIST OF SYMBOLS AND ABBREVIATIONS

AGFI	:	Adjusted-goodness-of fit index
AMOS	:	Analysis of a moment structures
AVE	:	Average Variance Extracted
BNL	:	Binomial logistic model
BRT	:	Buss rapid transit
CATI	:	Computer-assisted telephone interviewing
CBD	:	Central Business District
CFA	:	Confirmatory Factor Analysis
CR	:	Composite Reliability
CTA	:	Chicago Transit Authority
ECTR	:	European Commission Transportation Research
ERL	:	Express rail link
GKL/KV	:	Greater Kuala Lumpur/Klang Valley
GNI	:	Gross National Income
IPA	:	Importance-Performance Analysis
I-S	:	Importance-Satisfaction
KL	:	Kuala Lumpur
KLIA	:	Kuala Lumpur International Airport
KMRT	:	Kaohsiung Mass Rapid Transit
KTM	:	“Keretapi Tanah Melayu”
KV	:	Klang Valley
LISREL	:	Linear structural relations
LPTC	:	Land Public Transport Commission
LRT	:	Light rail transit

MI	:	Modification Indices
MLE	:	Maximum Likelihood Estimation
MRT	:	Mass rapid transit
NFI	:	Normal Fit Index
NKPI	:	National Key Performance Indicators
NKRA	:	National Key Results Area
NL	:	Nested logit model
NNFI	:	Non-Normed Fit Index
PEMANDU	:	Performance Management and Delivery Unit
PT	:	Public Transit
PUTRA	:	"Projek Usaha Sama Transit Ringan Automatik"
RP	:	Revealed preference
SEM	:	Structural equation modelling
SERVQUAL	:	Service quality model
SP	:	Stated preference
SPSS	:	Statistical package for the social science
STAR	:	"Sistem Transit Aliran Ringan Sdn. Bhd."
STD	:	Sample standard deviation
TDM	:	Travel demand management
TLI	:	Tucker-Lewis Index
TOD	:	Transit-oriented development
TRB	:	Transportation Research Board
UK	:	United Kingdom
US	:	United State of America

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LIST OF PUBLICATIONS

Article 1:

Koting, S., Karim, M. R., Mahmud, H. B., & Hamid, N. A. A. (2014). Mechanical properties of cement-bitumen composites for semi-flexible pavement surfacing. *The Baltic Journal of Road and Bridge Engineering*, *9*(3), 191-191.

Article 2:

Koting, S., Karim, M. R., Mahmud, H., Mashaan, N. S., Ibrahim, M. R., Katman, H., & Husain, N. M. (2014). Effects of using silica fume and polycarboxylate-type superplasticizer on physical properties of cementitious grout mixtures for semiflexible pavement surfacing. *The Scientific World Journal*, *2014*.

CHAPTER 1: INTRODUCTION

1.1 Research Background

In recent years, the use of rail transit system as a dependable and convenient way of travel has gained increasing popularity in urban cities around the world. Rail transit services receive positive support due to its high capacity, comfort, safety, and reliability (Wang et al., 2013; Zhang et al., 2015; Ding et al., 2015). Due to these circumstances, travel by rail transit has become more favourable and has increased in popularity and reputation. Litman (2007) highlighted that rail transit service is more cost effective and simultaneously reduces congestion cost by reducing travel time costs and ridership delays and encourages transit-oriented development (TODs). Although there were encouraging supports on rail transit services, one of the major challenges has been its ridership. The growth of private transport industries at the second half of the 20th century has seen a prompt decline in rail transport usage. There is a growing trend of dependency on private modes of transportation, particularly automobiles, in many metropolitan cities in developing countries, such as in South East Asia. However, the growth rate of motorization cannot be sustained by road network expansion. Hence, serious traffic congestion, increasing number of traffic accidents, excessive use of petroleum energy, and deterioration of air quality are undoubtedly at the top of the list in major cities problems. By taking four countries in the South East Asia region as example, namely, Philippines, Thailand, Singapore and Malaysia, severe transport problems resulting from rapidly increasing vehicle ownership and usage has become major issue in these urban cities. One of the reasons for increasing vehicle ownership and usage is due to insufficient supply and inferior quality of public transportation (Morikawa et al., 2003).

To deal with these problems, greater utilization of public transportation must be promoted. In order to make rail transit services work effectively, the system should be attractive enough to attract a large number of commuters. However, research carried out by Wibowo and Chalermpong, (2010) and Fillone et al., (2008), in Bangkok and Metro Manila found that those who live and have destinations within mass transit catchment areas are not the regular mass transit users. It means that the transit system in the study areas are suffering issues regarding ridership. In addition, it was found that the majority of beneficiaries of mass transit are likely to be existing public transport users in developing cities while switching from private car to mass transit is less likely to occur (Wibowo & Chalermpong, 2010).

Therefore, one of the identified factors with respect to quality attributes of public transport and to attract as many commuters as possible is by the improvement of rail transit accessibility (Biba et al., 2010; Redman et al., 2013). Accessibility of commuters to employment and for other purposes is one of the main focuses in urban transportation planning (Rastogi & Rao, 2003; Lau & Chiu, 2003; Lau & Chiu, 2004). Accessibility is defined as the degree to which public transport is reasonably available to as many people as possible (Redman et al., 2013). Accessibility involves freedom and ease of individuals to participate in a particular activity or set of activities (Lau & Chiu, 2004). Several previous researches indicate that the satisfaction on access to railway station can be a determinant factor to increase ridership if rail is chosen as a travel mode alternative (Lau & Chiu, 2004; Fillone et al., 2005; Wibowo & Chalermpong, 2010; Redman et al., 2013). The improvement on access facilities should be explored more thoroughly in order to provide a cost-effective and solution of lower rail ridership. Thus, there is a need to come up with improved planning on the existing rail access environments in order to improve long run ridership rather than expanding the rail system's coverage, which is costly, lengthy in implementation time as well as only serve as a short time solution.

The accessibility to rail transit system could be investigated in two aspects, namely, location and person accessibility (Dijst et al., 2003). The location accessibility is referred to the residential area, housing rentals, proximity to employment, and easy availability of transportation. Whereas, the person accessibility is referred to the personal aspects of the commuters, such as gender, age, income, and education, with income and gender being the main determinants (Sermons & Koppelman, 2001; Sanchez, 2002; Lau & Chiu, 2004). As for this study, it discussed mainly on person accessibility and rail access attributes aspect. Person or pedestrian accessibility to transit has been long recognized as an important factor in determining ridership. This is because transit use decreases as walking distance to reach station increases and it was shown that transit ridership declines exponentially with walking distance to the transit stop (Lau & Chiu, 2004). This research concentrates on accessibility to mass transit system in order to attract more passengers, especially to attract those who live within mass transit's catchments areas.

Furthermore, this study also investigated the service quality of each access mode that frequent rail users utilized to reach rail transit station in Klang Valley, Malaysia. The evaluation on the service quality for each access mode was based on their perception. It was agreed that improvement on the current access facilities will affect the public transport usage. Studies from advanced countries revealed that factors affecting mass transit ridership can be categorized into four groups: transit level of service, accessibility, land use, and users' characteristics (Zhao et al., 2002). The first group and certain elements of the second group are in the transit operator's domain where the operators have full authorities to enhance the system in order to gain more ridership. Therefore, in relation to this study, the service quality performance of access modes to rail transit station were investigated. According to Transportation Research Board (TRB), (2003), service quality is the overall measured or perceived performance of transport system service from the passenger's point of view. However, the clarification of quality transport system varies with respect to different level of society development, different socio-demographic and economic categories of population and importantly the transport system itself (Grujicic et al., 2014). It was believed that providing superior customer value and satisfaction are crucial to the competitive edge of a service or product (Grujicic et al., 2014). In other words, service quality and customer satisfaction are principal drivers of financial performance. If the customers are satisfy with the system or products, their loyalty level to the services or products will increase (Zeithaml, 2000; Grujičić et al., 2014). Therefore, improving customer satisfaction is a crucial issue for service providers in today's competitive global marketplace in order to stay abreast of competitors (Deng et al., 2011). Identifying the inefficiencies of the public transport system will help with improving service management, expanding coverage and increasing the attractiveness of public transport services which particularly refer to rail transit in this study. The key to providing effective customer service is the accurate determination of the customer's needs and response to them in a consistent manner to assure their satisfaction (Grujičić et al., 2014). Therefore, it is important for rail transit system operators as well as management agencies to consistently evaluate and assess their services in order to provide appropriate quality and on-par rail transit performance to become competitive in presenting travel trends (Topolnik et al., 2012). The findings from this analysis will give appropriate input on the access facilities that needs to be maintained and improved urgently. Therefore, the service operator and related authority can decide the appropriate actions. By implementing related analysis, the strategies taken will be more cost effective and practical. In order to improve service quality of current access mode to rail transit station, service providers and responsible authorities should therefore prioritize quality attributes that have higher importance levels and lower satisfaction levels.

Besides focusing on improving the access facilities to rail transit system in Klang Valley, the improvement on rail service quality level should also be focused. Numerous studies have investigated and succinctly summarized the causal relationship between service quality and customer satisfaction in the transportation sector (Bitner & Hubert, 1994; Githui et al., 2010; Yu & Lee, 2011; Eboli & Mazzulla, 2012; Borhan et al., 2014; Machado-León et al., 2016). Service quality refers to consumers' overall impression of the relative inferiority/superiority of an organisation and its services (Barsky & Labagh, 1992; Park et al., 2006). Meanwhile, customer satisfaction is determined by defining customers' perceptions of quality, expectations, and ability (Vanniarajan & Stephen, 2008). In order to achieve true customer satisfaction, the particular companies or corporations need to attain outstanding quality by providing attractive and excellent products or services to delight the customers. At the same time, the companies also have to manage and resolve the cause of direct complaints from the customers or users. Therefore, research on customer satisfaction is often closely associated with the measurement of service quality (Barsky & Labagh, 1992; Fillone et al., 2005). Various existing studies discussed a passenger's decision making process by correlation and causal relationship of the four constructs in single framework, namely, service quality, customer satisfaction, corporate image and behavioural intention (Lai & Chen, 2011; Kuo & Tang, 2013; de Ona & Ge Ona, 2014; Machado-León et al., 2016). While, several other studies discussed on the other dimensions, for instance, perceived value, experiences on service and role of involvement of public transport users (Park et al., 2007; Zhao et al., 2008; Machado-León et al., 2016). However, in this study, the causal relationship between service quality, rail users' travel experience and rail users' (customer) satisfaction on perceived importance of rail transit system traits were proposed in single framework. The final structural mode will propose the rail transit system traits which are of importance to the travellers.

1.2 Problem Statement

The public transport services in Klang Valley (KV) are served by rails, buses and taxis. Recently, rail transit is the most preferred mode of transport as it is punctual and the cost of traveling is reasonable. As it has its own track, the traveling time is not affected by the traffic congestion which happens almost everyday especially during the weekdays. The intra-city travel facilities in KV are served by Two Light Rail Transit ("Sistem Transit Aliran Ringan Sdn. Bhd" (STAR) and ("Projek Usaha Sama Transit Ringan Automatik") PUTRA LRT) , Kuala Lumpur (KL) Monorail system and KTM Komuter system. For the past 5 years, i.e. from 2010 to 2014, the number of ridership using these three transit system increased by 28.7%. Meanwhile, the number of ridership using KTM Komuter system increased by 34.2% (Ministry of Transport, 2014) for the past 5 years, i.e. from 2010 to 2014. However, as compared from 1985 to 1997, the percentage of public transport modal share has declined from 34.3% to 19.7% (Performance Management and Delivery Unit, 2013). This represents a major shift away from public transport services and in particular bus services, which is partly attributable to higher personal affluence leading to an increase in car ownership and also to deficiencies in the bus services (Performance Management and Delivery Unit, 2013). However, after comprehensive strategies in improving the public transport services, such as installation and operational of rail transit system, the percentage of public transport modal share has increased from 19.7% to 25.0% (Performance Management and Delivery Unit, 2013). However, the increment was lower as compared to other urban cities in Asia, for instance, Singapore (64.0%) and Hong Kong (74.0%).

Malaysia which is 43rd most populated country (2010 census) and newly industrialized country as of 2011 facing inadequate facilities of public transportation in order to fulfil demand from ridership especially in Klang Valley area. The magnificent population growth in Klang Valley area for over 20 years (3.0 million in 1990 to 6.3 million in 2010), increasing numbers of high income among city dwellers, and rapid expansion of urban areas in Klang Valley (KV) have subsequently led to an increase in travel demand. The increasing ownership of private vehicles, has created considerable pressure on the road network which has contributed to the problems of traffic congestion and air pollution. The excessive influx of private vehicles into Klang Valley has also brought the adverse impacts such as traffic congestion, air pollution that creates considerable pressure on the road network systems. It was estimated that 80 percent of the pollutants came from motor vehicle sources (Yahya & Sadullah, 2002). Nevertheless, the traffic congestion situation in city centre has continued to deteriorate. A study by Barter (1999) found that average public transport speeds in the Klang Valley are only 16km/hr compared to 26 km/hr in Singapore and 28km/hr in Hong Kong. In terms of traffic fatalities, it was recorded that there were about 4.3 accident fatalities case for every 10,000 registered vehicles (Marjan et al., 2007).

In Kuala Lumpur Structure Plan (2020) (City Hall Kuala Lumpur, 2003), the issue on poor accessibility to rail-based public transport has been highlighted to ensure the optimum use of rail transit services. Figure 1.1 shows the relative accessibility of bus and rail-based public transport in Kuala Lumpur, which is the most vital city in Klang Valley and also the capital of Malaysia.

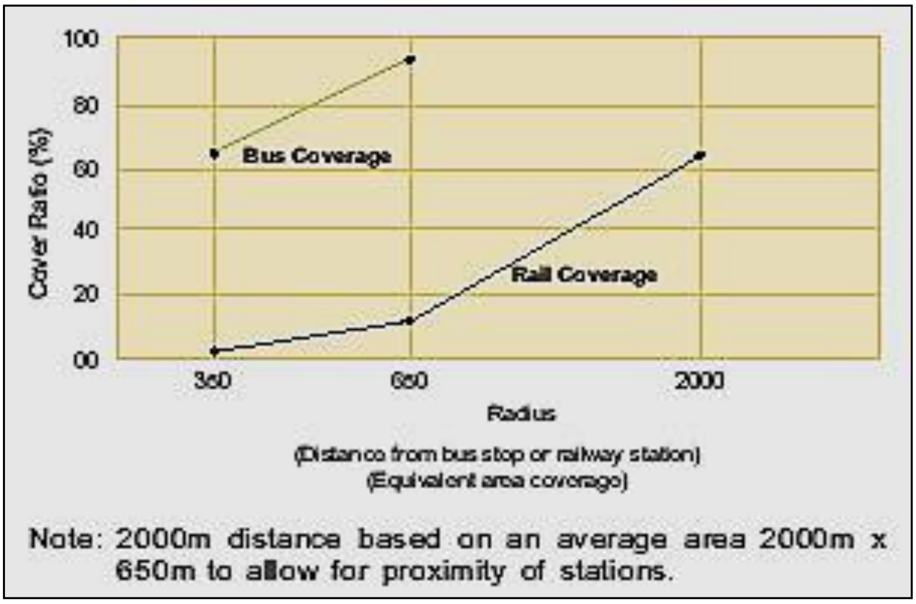

Figure 1.1: Rail and Bus Accessibility (City Hall Kuala Lumpur, 2003)

As depicted in Figure 1.1, it can be seen that rail-based public transport services are far less accessible as compared to bus services and, consequently, their ability to service patrons in a single trip from origin to destination is very limited (City Hall Kuala Lumpur, 2003). The two kilometres radius coverage of the feeder buses which operate to and from the stations are clearly not enough to ensure sufficient accessibility (Crane, 2000).

This study will focus on rail transit system accessibility in order to attract more passengers, especially potential passengers who live within mass transit's catchments areas. Study carried out by Oram and Stark (1996), showed that infrequent riders has great influences in increasing overall transit ridership. In addition, an application of the discrete choice modelling to access modes of the LRT and KTM Komuter systems can be an important tool to determine which improvements on the access attributes are needed and what will be the impact of these improvements to ridership. In addition, the findings will determine on the access modes improvement which usually used by travellers from their home as origin to work or school as destination. Since this study focuses on frequent rail users and private transport users, an interesting issue of the inertia effect will also be taken into account. Inertia effect is the effect that the past experiences may have had on the current choice. In other words, inertia effect has to do with tendency to stick or maintain with the past choice even though another alternative offers more appealing scenario. The findings from this study will be beneficial in order to improve the current rail transit accessibility in KV especially, to attract more potential passengers who live within mass transit catchment area.

Another important issue which relates to accessibility is the access modes performance. In the Klang Valley, five major access modes were used by travellers to reach rail station. The access modes are walking, taxi, bus, park and ride, and drop-off. Several complain on the access modes showed lack of facilities and the performance is not on-par. Among the complaints were lack of proper walkways to reach rail station, poor customer service quality, overcharging, refused to use meter for the journey and insufficient parking area for park and ride mode (Kumar, 2015; Lim, 2015; Zulzaha, 2016). Therefore, in this study, investigation on accessibility service quality elements with respect to satisfaction and importance level was carried out. However, one of the important service quality measurement elements that were not highlighted or less focused in past studies was accessibility for people with disability (Das et al., 2013; Grujicic et al., 2014). Therefore, all measurement on the satisfaction and importance level for each access mode was included the accessibility for people with disability. Therefore, the rail transit system will be more accessible to different groups of travellers. It was believed that improvements on the access modes facilities will increase the rail transit ridership especially for those staying in acceptable access distance.

It was briefly explained in the research background to also focus on the rail service quality improvement. Hence, in this study, investigation on the rail transit systems traits which are of important to the users will be carried out. Other factors, namely, service quality, customer satisfaction and rail transit user’s experience that were predicted to influence the perceived importance of rail transit system traits were also included in the study. The proposed structural model and relationships between proposed variables are scarce since there were no related studies focusing in those relationships. In the study by Fillone, et al., (2005), they highlighted three public transport system traits, namely, safety of urban travel, comfort and service reliability. In this study, more public transport system traits which related to rail transit system were also included in the model. The other traits, namely, travel time, travel cost, reliability, safety, comfort, and convenience were also believed to be the factors that highly influence the travel behaviour among public transport users (Tyrinopoulos & Antoniou, 2008; Friman & Felleson, 2009; Yannis & Georgia, 2008; Belwal & Belwal, 2010; Kamaruddin et al., 2012; Tippichai et al., 2010). Among all, travel time was found to be the most important trait for several urban cities throughout the world, for instance, Beijing, Bangkok, Kathmandu, Tokyo, and Kuala Lumpur as compared to other traits (Tippichai et al., 2010; Cantwell, et al., 2009; Khalid et al., 2014). In addition, it was found that one of the highly important factors in Tokyo was service reliability, convenience of service in Bangkok, and safety in Kathmandu and Beijing (Tippichai et al., 2010). Meanwhile, Cantwell et al. (2009) discovered that unreliable services, crowded and long waiting times influenced the public transport users in Dublin, UK. While, safety, supply and reliability, comfort and staff attitude played significant role in sustaining the service level in other European cities (Byrne, 2010; Shaaban & Kim, 2016). It was depicted that the degree of importance of these influential factors is fairly similar depending on the particular settings and different situations of the study, which are: 1) level of public transportation development; 2) size of the metropolitan area; and 3) individual demographics of commuters (Khalid et al., 2014). These findings will enable authorities, decision makers, service operators, and other researchers to identify the best practices and recommended relevant policies in the rail service sector. Consequently, this study considers all those hypothesised constructs to be analysed simultaneously, using Structural Equation Modelling, and hence, propose an integrated model of important rail transit system traits in Klang Valley. As the proposed model in this study was new, several limitations and constraints were anticipated and stated.

1.3 Research Gap

The study on accessibility to urban rail transit network receives less attention although it plays an important role in rail transit system. This is because efforts to increase ridership are mainly focused on the rail service itself (Kim et al., 2007; Brons et al., 2009). Additionally, research by Brons et al. (2009) revealed that satisfaction with the level and quality of the access to rail service is one of the crucial factors considered by travellers whether they will travel by rail or other travel modes. However, there are concerns on several evidence of urban transportation researches from major cities in the Europe and United States, that do not truly represent most situations in Asian cities due to the differences in city structure and social development (Lau & Chiu, 2004; Dimitriou, 1992). Hence, it was also discovered that issues on the poor accessibility in Klang Valley are not broadly covered. The past studies in Klang Valley on the mode choice are more concentrated on the influence of travel time, travel cost, distance, fuel price and etc. on modal shift from private vehicle to bus or rail and vice versa (Kamba, et al., 2007; Leong et al., 2009; Almselati, 2011). Hence, the findings from this study will contribute in filling the gap related to rail and private transport research.

Importance-Performance Analysis (IPA) integrated with confidence intervals method was usually applied in the quality-based marketing strategies. The IPA is used to assist practitioners in prioritising attributes when enhancing service quality and customer satisfaction. However, studies by Iseki and Taylor (2010), Das et al. (2013) and Grujičić et al. (2014) applied the IPA in the customer service quality of public transport sector. The satisfaction and importance level on current attributes of access modes and the significant/important role of each access modes attributes in Klang Valley is rarely covered. In relation to this study, IPA method was applied in the investigation of service quality for five different access modes from home to station. Therefore, as the proposed IPA analysis in this study was new, several limitations and constraints were anticipated and stated. Hence, the findings will contribute to fill the gap in the related service quality analysis which involved the public transport sector.

In this study, the causal relationship between service quality, rail users' travel experience and rail users' (customer) satisfaction on perceived importance of rail transit system traits were proposed in single framework. The proposed structural model and relationships between proposed variables are scarce since there were no related studies focusing in those relationships. In this study, the proposed structural model is unique because it considers new exogenous variables, which previously are untested relationship. Perceived importance, rail users' travel experience, rail users' satisfaction, and perceived quality are considered as latent variables with multiple indicator measures. In addition, by using the structural equation modelling approach, the possible mediator effect in the (1) rail users' travel experience-perceived service quality-rail users' satisfaction paradigm, (2) rail users' travel experience-perceived importance-rail users' satisfaction paradigm and (3) perceived service quality-rail users' satisfaction-perceived importance paradigm were considered. Hence, as the proposed model in this study was new, several limitations and constraints were anticipated and stated.

1.4 Research Aim and Research Objectives

The aim of this research is to evaluate and improve the accessibility from home to urban rail transit system in Klang Valley, Malaysia. The objectives of the research are stated as below:-

RO1: To identify and discuss the access trip pattern to rail transit station as well as travel behavior of frequent rail transit users and private transport users in Klang Valley, Malaysia.

RO2: To investigate the influence of access and travel characteristics scenarios as well as socio-demographic factors on the willingness of frequent rail transit users to travel consistently by rail and the potential of frequent rail transit users shifting to private transport.

RO3: To investigate the influence of access and travel characteristics scenarios and socio-demographic factors on the willingness of private transport users to travel consistently using private vehicle and the potential of private transport users shifting to rail transit.

RO4: To identify and investigate the current access modes indicators that are priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance and importance level.

RO5: To improve the walking surface for pedestrian accessing the rail transit station.

RO6: To evaluate the rail transit system traits that is of importance and priority to frequent rail users.

RO7: To develop the structural equation model for perceived importance of rail transit system.

1.5 Research Objectives, Research Questions and Research Hypothesis/Research Tools Relationship

The following research questions have been expressed to achieve the research objectives, which are linked with the research aim. The research questions, research objectives and research hypotheses or research tools relationships are tabulated in Table 1.1.

Table 1.1: Summary and Connection of Research Questions, Research Objectives, and Research Hypotheses

Research Questions	Research Objectives (ROs)	Research Hypotheses (RHs)/Research Tools
1. How is the current accessibility condition to rail transit system in Klang Valley, Malaysia? 2. What are the factors that influence frequent rail users to travel by rail transit? 3. What are the factors that influence private transport users to travel by private vehicles?	RO1: To identify and discuss the access trip pattern to rail transit station as well as travel behavior of frequent rail transit users and private transport users in Klang Valley, Malaysia.	No research hypotheses involved. The data was analyzed through descriptive statistics analysis and parametric test.
4. How far will frequent rail transit users travel consistently using rail transit under different hypothetical travel increment scenarios and socio-demographic factors before they consider shifting to private transport?	RO2: To investigate the influence of access and travel characteristics scenarios as well as socio-demographic factors on the willingness of frequent rail transit users to travel consistently by rail and the potential of frequent rail transit users shifting to private transport.	HF-1: Significant relationship is assumed between socio-demographic characteristics and access cost increment with probability of shifting to private transport mode.
		HF-2: Significant relationship is assumed between socio-demographic characteristics and access time increment with probability of shifting to private transport mode.

'Table 1.1, continued'

Research Questions	Research Objectives (ROs)	Research Hypotheses (RHs)
		HF-3: Significant relationship is assumed between socio-demographic characteristics and access distance increment with probability of shifting to private transport mode.
		HF-4: Significant relationship is assumed between socio-demographic characteristics and travel cost increment with probability of shifting to private transport mode.
		HF-5: Significant relationship is assumed between socio-demographic characteristics and travel time increment with probability of shifting to private transport mode.
		HF-6: Significant relationship is assumed between socio-demographic characteristics and rail frequency decrement with probability of shifting to private transport mode.
5. How far will *private transport users* travel consistently using private vehicle under different hypothetical travel increment scenarios and socio-demographic factors before they consider shifting to rail transit?	RO3: To investigate the influence of access and travel characteristics scenarios and socio-demographic factors on the willingness of private transport users to travel consistently using private vehicle and the potential of private transport users shifting to rail transit.	HP-1: Significant relationship is assumed between socio-demographic characteristics and fuel price increment with probability of shifting to rail transit mode.
		HP-2: Significant relationship is assumed between socio-demographic characteristics and travel cost increment with probability of shifting to rail transit mode.

‘Table 1.1, continued’

Research Questions	Research Objectives (ROs)	Research Hypotheses (RHs)
		HP-3: Significant relationship is assumed between socio-demographic characteristics and travel time increment with probability of shifting to rail transit mode.
		HP-4: Significant relationship is assumed between socio-demographic characteristics and access cost decrement with probability of shifting to rail transit mode
		HP-5: Significant relationship is assumed between socio-demographic characteristics and access time decrement with probability of shifting to rail transit mode.
		HP-6: Significant relationship is assumed between socio-demographic characteristics and access distance decrement with probability of shifting to rail transit mode.
		HP-7: Significant relationship is assumed between socio-demographic characteristics and rail frequency increment with probability of shifting to rail transit mode.
6. What are the access modes indicators that should be prioritized to improve the rail transit station accessibility?	RO4: To identify and investigate the current access modes indicators that are priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance and importance level.	➢ No research hypotheses involved. ➢ Each access mode used by frequent rail users was analyzed through Importance-Performance Analysis (IPA) Integrated with Confidence Intervals method.

‘Table 1.1, continued’

Research Questions	Research Objectives (ROs)	Research Hypotheses (RHs)
		The results obtained were compared to Traditional Importance-Performance Analysis (IPA) method.
7. How is the current performance of walking surface for pedestrian accessing the rail transit station?	RO5: To improve the walking surface for pedestrian accessing the rail transit station.	➢ No research hypotheses involved. ➢ Laboratory investigation on the appropriate material for walking surface is proposed.
8. Which rail transit traits are priority and important to frequent rail users when travelling by rail?	RO6: To evaluate the rail transit system traits that is of importance and priority to frequent rail users.	HI-1: A frequent rail user has a higher tendency to believe that rail safety is a priority when travelling with the rail transit system.
		HI-2: A frequent rail user has a higher tendency to believe that service reliability is a priority when travelling with the rail transit system.
		HI-3: A frequent rail user has a higher tendency to believe that comfort and convenience is a priority when travelling with the rail transit system.
		HI-4: A frequent rail user has a higher tendency to believe that rail integration is a priority when travelling with the rail transit system.
		HI-5: A frequent rail user has a higher tendency to believe that in-vehicle time is a priority when travel with the rail transit system.

‘Table 1.1, continued’

Research Questions	Research Objectives (ROs)	Research Hypotheses (RHs)
		HI-6: A frequent rail user has a higher tendency to believe that rail fare is a priority when travel with rail transit system.
		HI-7: A frequent rail user has a higher tendency to believe that access to the rail station is a priority when travel with the rail transit system.
9. What are the variables or factors which influence the perceived importance of rail transit system?	RO7: To develop the structural equation model for perceived importance of rail transit system.	H1: Rail users’ travel experience has a significant causal effect on the perceived importance of rail transit system traits.
		H2: Rail users’ travel experience has a significant causal effect on rail users’ satisfaction.
		H3: Rail users’ travel experience has a significant causal effect on the perceived service quality of rail transit system
		H4:Perceived service quality has a significant causal effect on the perceived importance of rail transit system traits
		H5: Perceived service quality has a significant causal effect on rail users’ satisfaction.
		H6: Rail users’ satisfaction has a significant causal effect on the perceived importance of rail transit system traits.

1.6 Conceptual Framework

A conceptual framework is used to outline possible courses of action or to present a preferred approach of an idea. In addition, the conceptual framework is the researcher's understanding of how the particular variables in the study connect or link with each other and it is the researcher's "map" in pursuing the investigation. In other words, the conceptual framework is particularly useful as an organizing device in empirical research. In quantitative research, the conceptual framework provides the structure or content for the whole study based on literature and personal experience

Before the conceptual framework is prepared, the research topic which is within the researcher's field of specialization is decided. Then, the review of the relevant literature on the topic is carried out. After that, the specific variables discussed in the literature are identified and the relationships are determined. The evaluation and review of the literatures, will be contributed in developing a conceptual framework design and research implementation. The conceptual framework as depicted in Figure 1.2 helps to keep the research on track by providing clear connections from the literature to the research problem and research questions in Section 1.5 and Table 1.1.

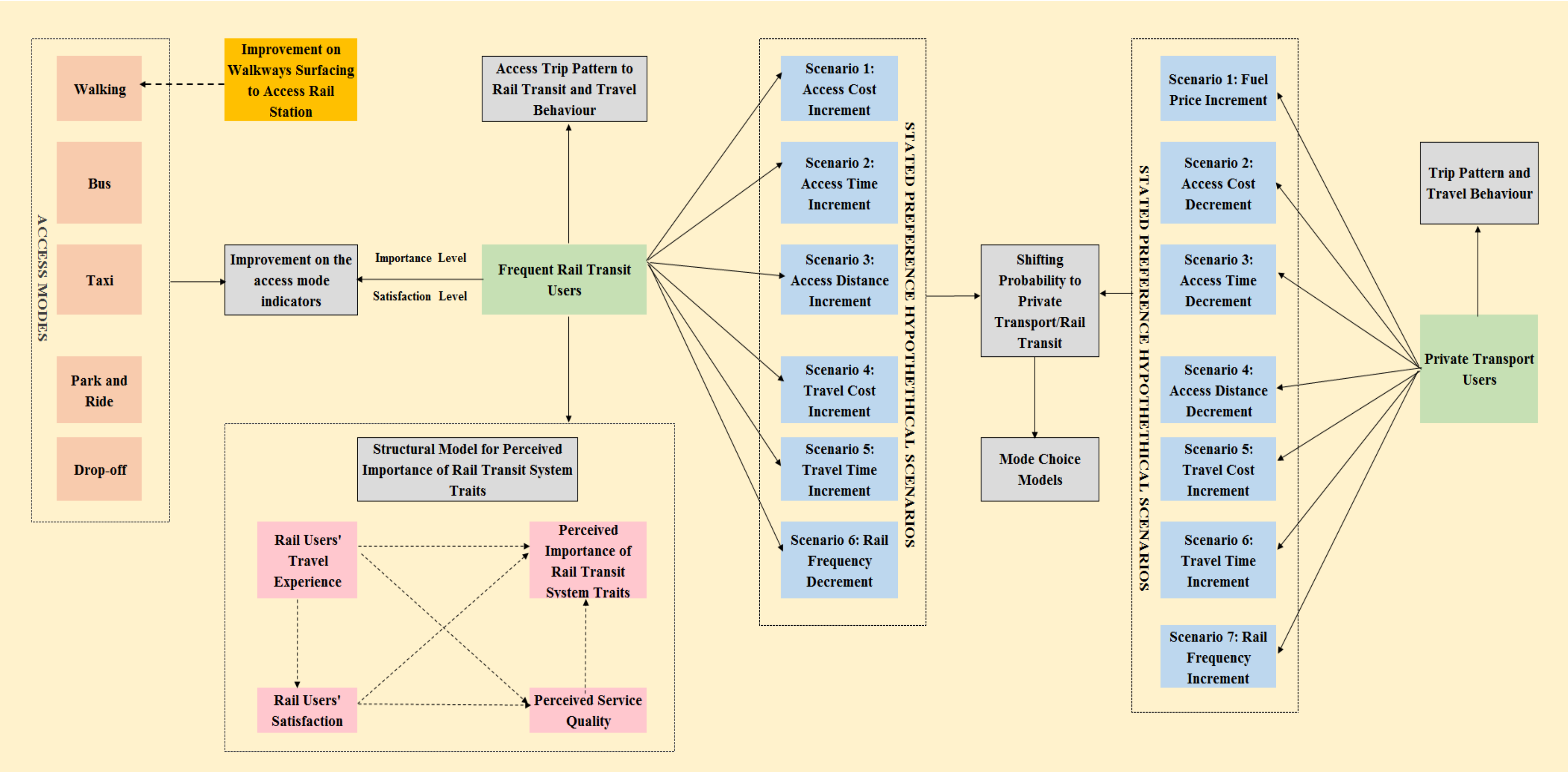

Figure 1.2: Conceptual Framework Derived Directly from the Research Question

1.7 Scope of Study

In this study, the respondents were (1) frequent rail transit users and (2) private transport users in Klang Valley, Malaysia. The frequent rail transit users were categorized as the respondents who used rail transit system at least 8-9 trips per week (including their return journey). Meanwhile, private transport users were categorized as the respondents who travel daily by their owns' vehicle and at the same time have had experienced travelling by rail transit at least once in 2 months. For frequent rail users, the study was focused on a potential travel mode shift from rail to private transport under six different access and travel characteristics hypothetical scenarios. For private transport users, the study was focused on a potential travel mode shift from private transport to rail under seven different access and travel characteristics hypothetical scenarios. The data was collected from a survey at various rail transit systems, several major shopping complexes, offices and universities in Klang Valley, Malaysia. Their trip origin and destination areas were identified. The access modes that the users utilized to reach rail station were identified and categorized. Five major access modes which have been used by both users were walking, taxi, bus, park and ride facilities and drop-off.

The private transport users in this study have had experienced travelling by rail previously in order to ensure they can provide inputs on the rail transit system questions in the survey. The study also involved the development of related model choice models by identifying and understanding the factors which likely to encourage their modal shift. Furthermore, the likely proportions of rail transit/private transport use were estimated after hypothetical improvements in different access and travel scenarios. The findings were used to identify the criteria that will trigger private transport users willingness to make changes in favour of rail transit as targeted in National Key Result Area (NKRA) under Government Transformation Programme 2014 (Performance Management Unit and Delivery Unit, 2014).

1.8 Thesis Structure

The thesis comprised of five chapters, as follows:

Chapter 1 presents background of the research, research objectives, problem statement and research gap, research questions, research hypotheses, scope of study, and study assumptions.

Chapter 2 provides discussion of the literature related to this research. The literature review includes the factors influencing transit ridership, strategies to increase transit ridership, transit accessibility concept, the significance of accessibility to public transport services and influence of access attributes. The summaries on travel mode choice studies as well as survey design techniques will also be discussed. The review on the related studies concerning the application of Importance-Performance Analysis method (IPA) and Structural Equation Modelling Approach (SEM) is included as well.

Chapter 3 presents the research framework, followed by explanation on the method that was used for developing the mode choice model, explanation on the method to investigate the Importance-Performance Analysis for each access modes and explanation on the Structural Equation Modelling approach to evaluate the importance level of rail transit system.

Chapter 4 presents the results and discussion on the descriptive statistics analysis, Binomial logistic regression analysis, Importance-Performance analysis and Structural Model analysis.

Chapter 5 presents the write-up on the potential of using semi-flexible pavement as the walkways surfacing to access rail station.

Chapter 6 presents a summary of findings and provides conclusion of the results. Additionally, this chapter also discusses limitations of the study, recommendation on related policies and suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

This chapter discusses relevant literature review for this research. The literature review includes the factors influencing transit ridership and strategies to increase transit ridership. Since this study is mainly focused on accessibility, the literature review which related to transit accessibility concept, the significance of accessibility to public transport services and influence of access attributes will also be summarised. The summaries on travel mode choice studies as well as survey design techniques will also be discussed. In addition to that, the review on the related studies concerning the application of Importance-Performance Analysis method (IPA) and Structural Equation Modelling Approach (SEM) is included as well.

2.1 The Review of Travel Mode Choice Studies

Mode choice is the process where the travel mode is determined. The travel mode types are private vehicles, walking, public transportation etc. The measurement on how desirable the travel mode as compared to one another is expressed by utilities. The concept of utility assumes that combination of various features or attributes of all alternatives will give one measure of utility which is consistent across all the alternatives within the set of choices. The most commonly used attributes included travel cost, travel time, number of interchanges etc. In order to determine the utility for each mode of transport, the travellers or commuters would calculate the utility of value of each attribute (i.e. travel cost, travel time and etc.). The mode with the highest utility will be choosen as their travel mode. By far, there are various forms of mode choice model, for example, probit, logit, generalised extreme value (GEV) model and mixed logit model. In this study, the binomial logit model was used. The binomial logit model is a special case of the multinomial logit model where there are only two alternatives. The detail on the binomial logit model is reviewed in Chapter 3.

2.1.1 The Factors which Influence Commuters Mode Choice

Generally, there are three factors which influence commuters to choose their mode of transport (de Dios Ortuzar & Willumsen, 2001; Onn, 2013). Those factors are;

1. Commuters' characteristics which referred to commuters' background, vehicle choice availability, vehicle ownership and household structure and income.
2. Trips characteristics such as travel purpose, trip distance and trip frequency etc.
3. Transport facility characteristics such as travel time, travel distance, travel cost etc.

The travellers' mode choice and likelihood to shift to other travel mode are strongly influenced and associated to above characteristics. Numerous studies in the past were investigated on the travellers' willingness to shift their current mode, usually private transport to public transport, either by rail or bus. However, all of these characteristics could be interrelated to each other and will directly and indirectly influence the public transport demand (Balcombe et al., 2004; Onn, 2013).

De Guzman and Diaz (2005) claimed that car characteristics and it advantage affect the higher car usage in recent years which had led to worst traffic congestion in Metro Manila. Based on the linear regression model, service quality of public transport and travel time showed significant difference in their choice of private vehicle. As total travel time using public transport increases, it is more likely that they will use the private vehicle. It was also discovered that the travellers were less sensitive to travel cost and willing to spend more as long as the travel time fulfilled their desire.

The study by Mercado and Newbold (2009) highlighted that the family network could play an important role in influencing both travel decisions and conditions. The use of private vehicles is popular among single person or person who lives alone as compared to those who live with family. In addition, elderly peoples were more likely to use private vehicles as compared to younger peoples.

Nurul-Habib et al., (2009) investigated the people's behaviour and perception towards transit, where a logit model combined with latent variable mode was developed to capture unobserved factors influencing people's shift to transit. Their study used 2007 transit customer satisfaction survey data from Calgary, and mainly concentrated on analysing the attitude of transit users towards different attributes of transit services. The results suggested that transit users in Calgary valued reliability and convenience more than the ride comfort. In addition, respondents were also provided with scenarios' specific time and cost variables for each mode and were asked to select the most feasible mode for commuting. The results of the study suggested that improving travel time for alternative travel modes has only a small effect on the mode shift and have less effect in reducing the demand for private vehicles. Furthermore, it was also found that by increasing the cost of private vehicle travel by introducing new charges will have a substantial effect on demand on a single driver. The summary of several studies with related to mode shifting is tabulated in Table 2.1.

Table 2.1: Several Studies With Related to Mode Shifting From Private to Public Transport and Vice Versa

Research	Findings	Policies suggested	Dependent Variable	Independent Variable	Type of Model
Limtanakool et.al, (2006) investigated how the socioeconomic factors, land use attributes, and travel time affect mode choice for medium- and longer-distance travel, and how the factors role varies across different trip purposes.	The analysis indicated that land use attributes and travel time considerations are important in explaining the mode choice variation for medium- and longer-distance travel when socioeconomic characteristics of travellers were controlled.	Physical planning which involved building in higher-densities area and the development of national and local specialization for urban activities. The employer-based initiatives like financial disincentives for car use. Restricted parking supply.	Travel purpose, i.e. commute, business and leisure	Socio-economic attributes, land use attributes and travel time	Binary logit model.
Kamba et al., (2007) identified factors preventing private transport users to shift to public transport.	The analysis discovered that reduced travel time and subsidized fares would encourage the use of public transport. Travel by private transport perceived as faster as compared to public transport. High traffic congestion when using bus and rail delay discouraged car users to use public transport.	Improvement on the public transportation facilities The implementation of traffic restraint policies such as in France and London Road Pricing.	Travel mode choice, i.e. bus, train and car.	Age, gender, travel time, travel cost, income, and car ownership	Multinomial logit model

'Table 2.1, continued'

Research	Findings	Policies suggested	Dependent Variable	Independent Variable	Type of Model
Kim et al., (2007) analysed factors which influenced trip mode choice from home to rail station.	This study found that some of the factors associated with increased shares of walking relative to other modes were full-time student status, higher income transit riders, and trips made during the evening. The crime made female transit riders more likely to be picked-up/dropped-off at the station especially at night. Bus availability and convenience showed that transit riders that have a direct bus connection to a light rail station were more likely to use the bus. Private vehicle availability was strongly associated with increased probability of drive and park, when connecting to light rail	The operating policies include providing frequent service, offering travel cards, offering free transfer to buses and some free travel, having effective marketing and advertising, and providing security staff on board and at stations. The transport policies include integrating the system into regional plans and urban projects, locating the stations at trip attractors or generators, integrating bus services with the new rail system and providing more park and ride lots at stations, and restricting automobile parking in the city center.	Mode choice to/from light rail station	Socio-demographic economic variables (age, gender, license availability, race, occupation, household income, vehicle availability), Trip characteristic (trip distance, land use) Trip facility (park and ride lot, bus availability)	Multinomial logit model

‘Table 2.1, continued’

Research	Findings	Policies suggested	Dependent Variable	Independent Variable	Type of Model
Vedagiri and Arasan (2009) estimated the modal shift from private transport to bus by the introduction of the public bus priority system.	Probability prediction curve to represent the possible modal shift of car users to public buses was developed.	The enhancement of level of service for public bus Introduction of exclusive bus lanes	Travel mode choice, i.e. car and bus.	Gender, age, walking time to bus stop, trip purpose.	Binary logit model
Buehler, (2011) identified the determinant factors of using non-motorized modes and comparison of the transport mode choice in USA and Germany	There was a significant difference in travel behavior in Germany and USA. German households’ makes a three times higher share of trips by foot, bike and public transport as compared to USA. Distance to public transport, population density and automobile access have a weaker influence in USA than Germany	Transport policy which make car travel slower, expensive and far from from public transport.	Mode of transport, i.e. public transport, bike and walk.	Access distance, spatial development patterns, socio-economic and demographic variables	Multiple regression analysis Multinomial logit model

'Table 2.1, continued'

Research	Findings	Policies suggested	Dependent Variable	Independent Variable	Type of Model
Miskeen et al., (2012) examined the behavior of intercity travel using disaggregate models, in order to project the demand of nation-level intercity travel in Libya. This study attempts to design mode choice model based on likelihood to shift to public transport.	It was indicated that the overall model is effective and showed higher estimation precision. In addition, it is the first model related to the intercity travel mode choice in Libya.	The gender analysis should be integrated into all transport planning before any project related to travel are executed.	Intercity mode choice, i.e. intercity bus and airplane	Socio-demographic economic variables and service attributes.	Multinomial logit model
Bai et al., (2017) estimated three kinds of logit models, i.e. Multinomial Logit Model, Nested Logit Model and Mixed Logot in order to determine the most appropriate model in analysing cost adjustment affection for Stockholm City.	Through comparison, the Multinomial Logit Model is selected to be estimated model.	Travel cost while using public transport is to be prioritized. This is because any decrement in public transport (PT) cost will positively influenced the public transport (PT) in the future.	Alternative trip modes, i.e., walk, bike, car, public transport.	Socio-demographic economic variables and travel characteristics.	Multinomial logit model Nested logit model Mixed logit model

Research	Findings	Policies suggested	Dependent Variable	Independent Variable	Type of Model
Zhang et al., (2017) developed a framework integrating treebased regression method and logit-based regression method to clarify the behavioral aspects of students' school travel mode choice.	It was indicated that car ownership, walking/cycling environment, and adults' convenience for escorting students significantly influenced the use of cars in school commuting. It was also discovered that students are more likely to use cars when their departure time is at rush hour compared to the other time.	The policies on school travel environment planning and management are proposed in order to improve the transportation services and facilities for students from primary to high schools.	Travel mode choice, i.e., walk, bus or subway and cycle.	Household characteristics, built environment, demographics and travel characteristics.	Tree-based regression model Logit-based regression model

2.2 Factors Influencing Transit Ridership

The term of transit that appears in this study refer to all forms of transit, including both bus and train. There were two factors which influenced transit ridership, namely, internal and external factors. The internal factors are the factors within the control of transit authorities and can be managed such as transit capacity, fare system, headway, station amenities, etc. Whereas, the external factors are all the factors that outside the transit authorities control such as a number of population in the rail station area, employment in station area, land use system, socioeconomic characteristics etc. However, the external and internal factors were related and influenced by each other. As an example, an increase in the number of population (external factor) in transit station area may change transit demand, which will affect the level of transit service (internal factor) (Wibowo, 2007). However, most of the transit study analysed the internal and external factors separately in order to understand the role of each factor. In comparison of those two factors, several researchers have found that external factors have a stronger impact on the ridership (Wibowo, 2007). Chung (1997) found the employment and regional development had greater impacts on ridership than fares based on data analysis of the Chicago Transit Authority (CTA) from 1976 to 1995. The study by Gomez-Ibanez (1996) found that ridership in Boston between 1970 and 1990 was affected more by external factors and less by internal factors such as fare changes. However, Liu (1993) discovered that external factors (i.e. income per capita, car ownership, suburbanization, and employment locations) had a greater impact on transit demand than internal factors such as fare decreases and service improvements. The factors affecting transit use from users' point of view is summarized in Table 2.2.

Table 2.2: Factors Affecting Transit Use from Users' Point of View

(Transportation Research Board (TRB), (2003), Vuchic, (2005) and Wibowo (2007)

Factors Affecting Transit Use	**Descriptions**
Service availability, related to time and location	Transit line is relatively close to user's origin and destination and available near the time of users' trip.
Frequency and transit headway	Transportation Research Board (TRB), (2003) classified these factors as "time reliability"
Punctuality	
Travel time (in-transit time)	Door to door time
Comfort	Defined as an absence of mental and physical strain and the presence of pleasant experience. Walking comfort to access and its environment is included.
Convenience	Service quality aspect that closely related to comfort. The parking space in the transit areas, number of feeder and egress are included.
Safety of all stage of the trip	Referred to absence of accident
Security of all part of the trip	Associated to absence of crime
User cost	Out of pocket cost spent by the users'

The European Commission Transportation Research, (ECTR) (European Commission Transportation Research, 1996) suggested various strategies in order to gain more transit ridership. Table 2.3 showed the direct and indirect strategies based on European Commission Transportation Research, (1996).

Table 2.3: Direct and Indirect Strategies to Increase Transit Ridership

(European Commission Transportation Research, 1996)

Direct Strategies		
Pricing ➢ Fare Levels ➢ Fare Structure ➢ Ticketing Technology ➢ Subsidy Regime **Priority Measures** ➢ Link Priority/ Right-of-Way ➢ Junction Priority **Regulatory Regime**	**Service Pattern** ➢ Extensiveness of Routes ➢ Distance to/from Stops **Service Quality** ➢ Service Frequency/ Travel Time ➢ Operating Hours ➢ Fleet Size	**Information** ➢ Information Provision ➢ Publicity/Promotion **Other** ➢ Park-and-Ride ➢ Integrated Approach

➢ Market Regulation ➢ Operational Regulations ➢ Quality Regulations	➢ Vehicle Characteristics ➢ Bus/Rail Stop Quality ➢ Interchange Quality ➢ Quality/Number of Staff	
Indirect Strategies		
Car Ownership ➢ Taxation of Car Ownership ➢ Restrictions on Car Ownership **Car Use, General** ➢ Fuel Tax ➢ Restrictions on Car Use ➢ Car Vehicle Specification	**Car Use, Area-Specific** ➢ Traffic Calming ➢ Access Restriction ➢ Road Pricing ➢ Parking Availability and Its Fee in Transit Stop Area ➢ Parking Enforcement	**Other** ➢ Land use planning, especially within Transit Coverage Areas

Based on Table 2.3, the indirect strategies focus intensively on car usage. The strategies are more on car usage restriction in order to encourage more shifting from car to transit. The direct strategies aim to increase efficiency and effectiveness of transit operations and focused on internal factors. In addition, most of the direct strategies were carried out by transit authorities, such as the strategies related to pricing, service quality, and information. However, some strategies need to conduct together with transit regulator, i.e. government, such as the strategies of priority measures, regulatory regime, and service pattern. On the other hand, indirect strategies focus on external factors. However, the strategies seem difficult to apply in mass transit system in developing countries. The study by Fouracre et al., (2003) found that in developing cities, the majority of beneficiaries to improve mass transit (i.e. busway, LRT, and MRT) were likely biased towards existing public transport users and therefore, encouragement on shifting probability from private car users to mass transit was less likely to be successful.

2.3 Transit Accessibility Concept

According to Odoki et al., (2001), accessibility is a function of the mobility of the individual, of the spatial location of activity opportunities relative to the starting point of the individual, and of the times at which the activities are available. In short, Lau and Chiu (2004) defined accessibility as the ability of an individual to take part in a particular activity or set of activities.

A number of transit accessibility studies associated to how people with disability access and use transit services (Lau & Chiu, 2004; Wibowo, 2007; Wibowo & Chalermpong, 2010). The disabilities related to transit accessibility might be in many forms such as financial disability, (for example, cannot afford the transit fare), social disability (for instance, feel unsafe to use transit at night), virtual disability (for instance, unable to access information of the transit service due to language barrier or insufficient information provided), etc. Due to the different disability of an individual or traveller, transit accessibility can be defined as a result of the interaction between transit element and people when they attempt to use it (Wibowo & Chalermpong, 2010). Accessibility to transit system depends on the connecting transport systems, the location of the job and housing, and availability of time with respect to specific activities (Odoki et al.,2001; Lau & Chiu, 2004). However, personal aspects of the travellers which refer to their socio-demographic background, such as gender, age, education, and income also influence the accessibility (Dijst et al., 2002). In this study, the accessibility of travellers to reach rail station is mainly focused on person accessibility and access trip characteristics (Netipunya, 2006; Bergman et al., 2011; Redman 2013). With regards to person accessibility, income and gender are the main determinants (Sermons & Koppelman, 2001; Sanchez, 2002; Lau & Chiu, 2004). However, currently, the availability of vehicle also influenced the access mode pattern to transit station (Hamid et al., 2007; Hamid et al., 2011).

2.3.1 The Significance of Accessibility to Public Transport Services

Getting into rail station or going out from rail station is an important part of a rail journey and therefore must be accounted for in the efforts to increase rail use (Givoni & Rietveld, 2007). The accessibility to rail station can be a factor in determining if the railway is chosen as a travel alternative (Rietveld, 2000; Krygsman et al., 2004). It was envisaged that improvements to the accessibility of stations might be cheaper and more cost effective than improvements to the actual train journey (Wardman & Tyler, 2000; Wibowo, 2007). In addition, improving the access to railway stations is important and can be worthwhile for some reasons. For instance, better access to rail station will lower the disutility from longer traveling which will benefit current rail users and therefore is socially justifiable (Wardman and Tyler, 2000). In addition, the improvement on the public transport service to access rail station would contribute to car-free life style (Martens, 2004).

The accessibility to work is always the focus of urban transport planning. Most urban transport studies investigated the accessibility problems in cities with land-use dispersion structure which are dominated by private vehicle. However, the structure of urban cities and social development in most Asian cities are dissimilar from those of the cities in the United States and Europe (Lau & Chiu, 2004). Therefore, some research evidence on urban transport studies might be inappropriate for Asian cities (Dimitriou,1992). Although access has been recognized as one of the improvement strategies in public transportation planning, (Federal Transit Administration, 2010; de Vuk 2005), however, very few of the studies have addressed the effects of access to increase the public transport ridership.

2.3.2 Access Attributes and Travel Characteristics

Rastogi and Rao, (2003) analyzed the travel characteristics of commuters accessing transit stations in Mumbai, India with an aim to determine related policies that can enhance the current transit access environment. In their study, the investigation on the access travel characteristics included the access mode use pattern, access modes availability, access environment satisfaction and characteristics of the access leg of a trip as compared to primary and egress legs. In the study area, the available access and egress modes to reach rail stations and bus stops in the city were walking, cycling, private vehicles, taxi, bus, and auto-rickshaw. One of the important findings from their studies was to improve the utility of green modes, for instance, walk and cycling as compared to non-green access modes (private vehicles). In their study area, walking was found as the dominant access mode within an access distance of 1250 metres. About 86.0% of the commuters walked within this access distance. It was also proposed that by providing proper pedestrian facilities, sheltered walkways and direct connectivity along the route to rail transit station and bus stops, will promote walking as a convenience access mode. Another important finding was the waiting time for access mode is six times higher than egress mode, which indicated higher availability of egress modes as compared to access modes. The longer waiting time for a bus as compared to auto-rickshaw is higher due to the roads congestion near transit station also due to unavailability of exclusive bus lanes.

A study by Rodriguez and Targa, (2004) determined to which extent the access to Bus Rapid Transit (BRT) affect the land and property values. It was discovered that for every 5 minutes additional walking time to a BRT station in Bogotá, Colombia, the rental price of a property decreases by between 6.8 and 9.3%. This condition was due to the structural characteristics, vicinity attributes and proximity to the BRT corridor. Therefore, this indicated that potential BRT users' evaluated accessibility as an important quality in PT services and every 5.0 minutes was significant to them. This finding was supported by Chien and Qin (2004). In their study, a determiner of accessibility in PT is the density and locations of PT nodes along the routes, which in their study refer to bus stops. It was discovered that users' valuation of time, speed of accessing the node, and demand were the factors which influenced the optimal number and locations of PT stops and not because of the route length (Chien and Qin, 2004) .

Lau and Chiu (2004) investigated the relationship between the accessibility of workers and the compact city structure in Hong Kong. Their study was mainly focused on influences of the land-use policy and public transport systems development on the workers accessibility to workplace. Based on their findings, 79.0% of the respondents used public transport, 13.0% of them walking and only 5.0% of the respondents drive private vehicles to jobs everyday. Meanwhile, about 21.0% of the respondents have to transfer to another public transport mode in their daily work trips, which majority of the transfer involved railways. In Hong Kong, 90% of the trips were done by public transport. The model, which incorporates factors such as transfers in work trips, employment status, income, gender, marital status and living in accessible areas, was developed. Their findings showed that the short distances between residential areas and employment locations, high population density and the diverse provision of public transport modes minimized the travel time differences between the high income and low income workers and between workers who live near the railway lines and those who live in inaccessible districts. This indicated that variability in accessibility to jobs is different in a compact city structure with a hierarchical transport network from the in cities in Europe and the US. However, it is noteworthy to mention that the public transport modes integration and higher proportion of workers, who need to transfer to other public transport modes, increased the work trips costs although it showed no significant difference in affecting the accessibility of workers to public transport services. This is a common transport network issue in other world cities which are dominated by public transport.

Hamid et al., (2007) discussed the potential of park-and-ride system as a prominent access mode in high car ownership city, i.e. Kuala Lumpur. It was discovered that a combination of travel time by rail, income, trip purpose, egress mode and types of rail fare is statistically significant in influencing the use of park and ride facility. It was reported that over 50% of the park-and-ride users for three stations, namely, Shah Alam, Rawang and Seremban travelled within 9km to reach their stations. Based on their findings, those who are on non-compulsory trips would park for shorter hours as compared to those on compulsory trips. The compulsory trip users are those that park more than 8 hours. In addition, it was expected that higher income group would use their private vehicle to reach rail station. However, some concerns were noted from this study. The influence of egress distance should be considered in planning because unacceptable egress distance would directly reduce the potential to use park and ride facilities.

Givoni and Rietveld (2007) investigated the profile of the access and egress modes on journeys to and from railway stations in the Netherlands. In addition, Givoni and Rietveld (2007) also estimated the effect of passengers' perception on the station, the journey to the station and their overall perception on traveling by rail. It was highlighted that majority of passengers used bicycle, walking and public transport to reach rail station and availability of private transport did not show a strong influence on the access mode choice. This was due to transport network qualities and inadequate parking areas and facilities at rail stations. It was also discovered that passengers would trade public transport for bicycle and walking if average distance to the station is lower. However, passengers tend to avoid using railway as they perceived the station and its accessibility levels is in low quality. Therefore, the service qualities at the station and the access/egress facilities have an important effect on the general perception of traveling by rail. It was envisaged that those who use the rail less regularly, will be more sensitive to any improvements as compared to those who do not use it at all.

It was depicted in Loader and Stanley (2009) study, that improvement of accessibility to public transport (PT) services showed ridership changes in Melbourne, Australia. Previously, about 69.0% of the bus users in Melbourne do not have a driving license and 73.0% of them also do not have access to cars. The low accessibility to PT services has required car usage among low-income households and became a burden to them. The strategies that have been implemented to improve the accessibility was by extending PT routes or network to outside Melbourne and low income suburbs areas. The PT service was also available in the weekend and evening. In addition, the users were more convenient as they were less dependent on their private vehicles because PT route can access other places which previously out of coverage. However, Loader and Stanley (2009) also highlighted improvement on the service quality of PT services should achieve at least at a minimum level to ensure the increment of ridership. This is because only PT routes with reasonable service performance will attract new ridership.

The study by Wibowo and Chalermpong, (2010) focused on the accessibility to mass transit system in Bangkok and Manila Mass Transit Systems. Findings from their study discovered that access cost, access time and access distance have significant effect in influencing people to shift from their current mode to mass transit system. As expected, the car availability was the crucial factor which influenced the tendency to use mass transit system. However, users' depicted higher effect on the travel time improvement as compared to improvement related to cost. Wibowo and Chalermpong (2010) proposed that by enhancing the convenience aspects along the way to stations, for instance, proper walkways and providing shelter, the access experience to reach transit station will be improved although the current actual distance is similar. It was also proposed that within acceptable walking distance, the improvement on walking environment quality could be an important strategy to increase mass transit system ridership. Whereas, for longer distance, the improvement on feeder bus service is indispensable and providing more park and ride facilities near station could increase mass transit attractiveness for private transport users. However, a concern arise in the developing countries such as Bangkok and Manila that the improvement on mass transit systems would be more beneficial to current public transportation users rather than private transport users. Therefore, Wibowo and Chalermpong (2010) suggested concentrating more on the strategies to persuade transit captive users to shift to mass transit system rather than focusing more on private transport users.

2.4 Review on the Survey Design: Revealed and Stated Preference Techniques

In this study, the Revealed Preference (RP) and Stated Preference (SP) methods were used to design the survey questions. Both RP and SP methods are widely used in transportation research to investigate the travellers' preferences for travel alternatives. The RP data involved the trip diaries of the travellers and SP data revealed the travellers' responses on the hypothetical scenarios. Several major advantages of the SP over RP approach are; (1) the service providers cannot observe the response to a non-existing alternative in RP method while in SP method, it is possible to observe the response to a non-existing/forthcoming alternative, (2) the RP data may also contain measurement errors in the attribute values while SP data is free from this source of error and (3) the ranges of attributes are limited in RP survey design but a wide range of attributes can be tested in SP design (Louviere et al.,2000; Cherchi & de Dios Ortuzar, 2006). However, one of the major disadvantages of SP design is due to policy response bias. This situation refers to the respondents' intuition in which they might agree to use the system or product while answering the SP questions, though in actual or real situation, they will not consider shifting to different travel mode as predicted. In addition, the use of SP technique received mixed responses due to it hypothetical nature (Cherchi & de Dios Ortuzar, 2006). However, Louviere et al. (2000) highlighted that data from SP techniques can be reliable if the survey is well designed and was clearly explained to the respondents.

Three types of questionnaire can be used in SP design. There are ranking, choice or rating. In choice design, the respondent will choose the hypothetical combination of attributes, which is more favourable to him, and the researcher has an actual prediction of the respondent's choice in a hypothetical situation. Meanwhile, in a ranking questionnaire, the respondents have to arrange the hypothetical situations according to their preference. The task becomes more complicated in rating because the respondents must be able to order their responses in order of preference but they must also be able to indicate how much they prefer one alternative over others (Ahern & Tapley, 2008). In this study, the choice experiment design is used (Cho and Kim 2007; Ahern & Tapley, 2008; Chen et al. 2011). However, the choice experiment design which was used in this study has been modified and is slightly different from the current practice because each increment level of rail travel and access attributes scenarios, namely access cost, access time, access distance and etc. was answered individually and sequentially. The detail on this SP design is explained in Chapter 3. In spite of the SP method limitations, the SP method and design have been widely used in choice modelling because of its advantages, particularly in prediction of demand for new modes and services. This condition has led to innovations in design and data collection techniques for the SP exercises.

Vedagiri and Arasan (2009) used revealed preference (RP) and (2) stated preference (SP) approach to investigate model shift from private vehicles to public buses. The SP approach was used to analyse the response of people towards hypothetical choice situations, and cover a wider range of attributes and conditions than the real system. The variables which influenced the shifting probability were age, gender, walking time to bus stop, trip purpose, and travel time difference.

Dissanayake and Morikawa (2010) proposed the Nested Logit model (NL) to investigate the travel behaviour of household in relation to vehicle ownership, mode choice and trip sharing decisions in Bangkok, Thailand. The model is analysed using a combined estimation of RP/SP data. Two models, a RP NL model and a combined RP/SP NL model, are estimated to analyse household travel behaviour and attitudes to existing modes and to forecast commuter attitudes to a proposed Mass Rapid Transit (MRT) system. It was discovered that Central Business District (CBD) travel, long travel distance, household income, job status, age of travellers and presence of school children in households are found to be the key aspects in household travel decisions. Based on the finding, it was found that a combined estimation of RP/SP data is an effective method to be used in complex travel behaviour and to forecast travel demand for new transport services. As in this study, the commuters preferred to use MRT System even though the service is not fully implemented.

Chen et al. (2011) applied stated preference survey (SP) to attain travel behaviour data of Beijing residents. An improved time value model for the public transport systems was suggested in their study which included traveller's income as a variable. An analysis of travel time values is one of the most important parts of traveller's travel cost estimation. According to the stated preference (SP) survey data for Beijing residents, the factors which influence public transport values of travel time are analysed and a Logit-based model is used. Based on their findings, the travel time values for work are generally higher as compared to leisure purpose. In addition, the waiting time values are higher than transferring time values and in-vehicle time values. As expected, the waiting time values are higher for those who have to transfer than those without transferring.

2.4.1 The Influence of Inertia Effect on Modal Shift

One of the important issues in travel choice modelling is inertia effect. The inertia effect is related to psychological studies on attitudes (Cohen & Dov, 1998). The change in attitude found that participants are reluctant to reduce their confidence in their current habit or choice even after they receive new information which against their original estimate. Researchers have hypothesized that this "inertia effect" is due to participants' psychological commitment to their initial judgments (Ramasco, 2007; Brook & Scott, 2013).

There were many travel behaviour studies that have been done and most of them indicated that past behaviour is a strong influence or predictor of future behaviour. Inertia effect is the tendency to stick with the past choice even another alternative become more appealing or attracting (Swait et al., 2004; Cantillo et al., 2007; Yanez et al., 2009; Cherchi & Manca, 2011; Cherchi et al., 2013; Meloni et al., 2013). As this is due to the fact that individuals will tend to repeat the same choices if there are no external changes occurring (Meloni, 2013). It was discovered that, attributes such as car availability, miles travelled, seasonal public tickets, number of trips per week are indicators of habit (Gärling & Axhausen, 2003).

One of the studies which investigated the presence of inertia effect in travel behaviour was conducted by Meloni et al., (2013). In their study, the individual propensity to voluntary travel behaviour change by combining concepts from theory of change with the methodologies deriving from behavioural models was analyzed. A two-week panel survey was carried out which consist of providing car users with a personalized travel plan after the first week of observation (before) and using the second week to monitor the post-behaviour (after). The panel data was used to estimate a Mixed Logit in a personal vehicle or a light metro choice and a Multinomial Logit for the decision to change behaviour. It was found that individuals who travel more than 25k kilometres every year, are less likely to change their travel mode behaviour. This indicated that travel behaviours among private transport users are difficult to be modified (inertia effect). The travellers with higher work trips frequency are more likely to change in the second week. Results from both models showed the relevance of providing information about available alternatives to individuals while promoting voluntary travel behavioural change.

2.5 The Review on Importance-Performance Analysis method (IPA)

The Importance-Performance Analysis (IPA) is a straightforward and simple but effective technique that has been broadly utilized in customer satisfaction study which was expressed as a function of both expectations related to importance and performances (Martilla & James, 1997; Eskildken & Kristensen, 2006; Das et al., 2013). The current practices of IPA are applied in determining service quality of products or services in various field and areas (O'Neill & Palmer, 2004; Das et al., 2013; Sever, 2015). The IPA is applied to identify the parameters or attributes of products or services that are priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance (Eskildsen and Kristensen, 2006; Wu and Shieh, 2009; Grujicic et al., 2014). Several applications of IPA method in determining service quality of public transport are revised as follows.

Iseki and Taylor (2010) identified which transit stops and stations attributes that passengers found most important and which need the most improvement at 12 transit stops and stations around Los Angeles. In this study, Importance-Satisfaction analyses and ordered logistic regression was conducted to examine the transit users' perceptions of the services and built environment at transit stops and station. The survey was conducted among 749 users. It was found that the users were less affected by the physical characteristics of the transit stops and station facilities. The users were concerned more on frequent, reliable service and safety when travelling by transit.

Research by Das et al., (2013) identified the commuters' satisfaction and effectiveness of Monorail service in Kuala Lumpur. The traditional IPA method was applied in their study. The findings from analysis provided an insightful view on the critical service facilities or attributes of Monorail system that should be maintained and priority to be improved. Based on their findings, the service facilities with highest important level but have lowest performance level (satisfaction) were (1) waiting area and escalator, (2) seats in the train, (3) comfort during boarding (4) additional coach and routes and availability of parking and other public transport at the surrounding area.

Grujicic et al., (2014) investigated the bus service quality in Belgrade based of the users' point of view. In their study, the IPA integrated with confidence intervals was applied. The inclusion of confidence intervals in the Traditional IPA method was introduced by Wu and Shieh (2009). The IPA integrated with confidence intervals enable the service operator and decision maker to determine the strength and weaknesses on the current public transport facilities by considering the sample variability and error. This is because the confidence intervals (95%) displayed the range in which the population parameter will be the most likely. Based on their analysis, the attributes or elements that have the potential to be located in Quadrant QIV were travel time, vehicle frequency, parking place and pavement quality. These attributes were considered because they appeared in confidence interval range after analysis. Therefore, the application of integrated IPA with confidence intervals reduced any shortcomings when Traditional IPA was applied by providing appropriate and reasonable action plan for each service attributes.

2.6 The Review on Structural Equation Modelling (SEM) Approach

Nowadays, the application of Structural Equation Modeling (SEM) has gained popularity across many disciplines since the technique appeared in the late 1960s due to its generality and flexibility (Lei & Wu, 2007). SEM is a second generation multivariate technique which was developed due to some limitations in the traditional Ordinary Least Squares (OLS). Until today, the methodology is still developing and subject to challenge and revision. In this study, SEM was adopted because it offers many advantages in excess of standard regression methods. Among the advantages of SEM application were, (1) SEM is a good analysis tool to elaborate relationships among hypothetical constructs that have causes and effects, (2) SEM can analyze complex relationships between observed and latent variables from multiple independent or exogenous variables and dependent or endogenous variables simultaneously (Fillone, et al., 2005; Vanniarajan & Stephen, 2008; Tyrinopoulos & Antoniou , 2008; Friman & Fellesson, 2009), (3) SEM has model fit statistics to assess the matching of model and data (Fillone, et al., 2005; Vanniarajan & Stephen, 2008; Tyrinopoulos & Antoniou , 2008; Friman & Fellesson, 2009) and (4) SEM could model the error terms and handle the correlated errors among response items (Kline, 2005).However, despite of advantages, there were some drawbacks and limitations regarding SEM. Among the disadvantages were (1) The model fitness tests are sensitive to sample size and often used to analyse complex relationship between multivariate data, which lead to model rejection, (2) SEM technique involves a large size sample and conclusions interpreted based on small sample size may lead to estimation problem and unreliable findings. The large sample size is needed to obtain stable covariances/correlations estimation (de Carvalho & Chima, 2014) and (3) the data are seldom multivariate normal and using sample size and non-normal data may lead to estimation problems and unreliable results. Nevertheless, SEM is still a very powerful analytical tool with many benefits over other statistical methods (Byrne, 2010; de

Carvalho & Chima, 2014). In this study, Structural Equation Modeling (SEM) was adopted to explain the relationships among multiple variables by investigating the interrelationships structure which was expressed in a series of equations. According to Hair et al., (2010), in a different manner from other multivariate techniques, SEM investigates more than one relationship simultaneously as compared to ordinary statistical analysis.

2.6.1 The Development of Structural Model to Evaluate Perceived Importance of Rail Transit System Traits

In the dense populated urban cities, the use of public transportation systems is the most efficient means for moving large number of people and to make the city liveable (Eboli & Mazzula, 2012). In addition, increasing the use of public transport is one of the most convenient strategies for improving the problems arise from the excessive use of the private car in most urban areas, i.e. congestion, pollution, noise, etc (Eboli & Mazzula, 2015). The transit services are characterized by various aspects, since users have different perceptions on the service aspects and factors influencing each aspect. The heterogeneity of these perceptions is due to the qualitative nature of some aspects characterizing the services, different attitudes of the users towards the use of transit services, different ways in which the users understand the service aspects, user socioeconomic characteristics and tastes (Cirillo et al., 2010).

Hence, providing high levels of service quality is crucial to optimize the public transport services and attract potential users. The passengers' perception and view is essential in evaluating the transit service quality because they are the real users of the services and therefore, it was crucial to obtain information on their service judgement. In relation to this study, improvement on rail service quality level involved appropriate input on rail transit system traits which are of importance to the rail users in order to achieve true customer satisfaction and fulfil their needs. Therefore, in this study, the perceived importance of rail transit system traits was evaluated by focusing on the influence of three exogenous variables (latent constructs), namely, (1) rail users' travel experience (2) perceived service quality (3) rail users' satisfaction. Numerous literatures investigated the causal relationship between the users' satisfaction and service quality. However, there were limited numbers of studies on the rail users' travel experience construct and perceived importance construct. Several literatures on the causal relationship between the users' satisfaction and service quality, and revision on the rail users' travel experience construct and perceived importance construct were reviewed in the following sub-sections.

2.6.2 The Relationship between Service Quality and Users' Satisfaction

Service quality refers to consumers' overall impression of the relative inferiority/superiority of an organisation and its services (Park et al., 2006; Barsky & Labagh, 1992). Meanwhile, customer satisfaction is determined by defining customers' perceptions of quality, expectations, and ability (Vanniarajan & Stephen, 2008). In order to achieve true customer satisfaction, the particular companies or corporations need to attain outstanding quality by providing attractive and excellent products or services to delight the customers. At the same time, the companies also have to manage and resolve the cause of direct complaints from the customers or users. Therefore, research on customer satisfaction is often closely associated with the measurement of service quality because most service operators or companies assumed that there is a strong relationship between customer satisfaction and consumer behaviour (Barsky & Labagh, 1992; Fillone et al., 2005; Park et al., 2006). Hence, it is understood that the customers with high satisfaction tend to have higher purchase intention and 'word-of-mouth' communication (Park et al., 2006).

Although there are number of studies examined the relationship between service quality and customer satisfaction, arguments and debate arise on the distinction and association between service quality and customer or users satisfaction. In general, several studies agreed that customer satisfaction and service quality are conceptually distinct (Cronin & Taylor, 1992; Bitner & Hubbert, 1994; Park et al., 2006). However, there were debates about the causal order between service quality and customer satisfaction. The studies by Parasuraman et al., (1988) and Spreng and Mackoy (1996) claimed that service quality leads to customer satisfaction. In contrasts, Bitner, (1994) and Bolton and Drew (1991) claimed that customer satisfaction is an antecedent of service quality. In addition, several research concluded that there is no relationship exists between service quality and customer satisfaction (Fornell, 1992; Teas, 1993). It can be summarized that the causal order of service quality and customer satisfaction is varied depending on the situations and specific settings. Therefore, it is worth studying the causal order between service quality and customer satisfaction in rail transit service.

Structural equation modelling (SEM) was adopted in various transportation areas. For instance, SEM is used in investigating the customer satisfaction on public transport services (Fillone et al., 2005; Tam et al., 2005; Rahaman & Rahaman, 2009). In addition, some applications of SEM were proposed to analyze the land-use and transport interactions (Van Acker et al., 2007; Abreu eSilva and Goulias, 2009).

Research by Park et al., (2006) investigated how perceived price, airline service quality, perceived value, passenger satisfaction and airline image determine passengers' future behavioural intentions. The study was mainly focused on the Australian international air passengers. In their study, SEM using a maximum likelihood estimator was applied. It was discovered that there were significant relationships between all the variables except for three paths. The three insignificant paths were the relationship between 'perceived price and passenger satisfaction', 'service quality and airline image' and 'perceived value and airline image'. Meanwhile, perceived price, perceived value, passenger satisfaction, and airline image were each found to have a direct effect on passengers' future behavioural intentions. These variables were found to have directly or indirectly related to Australian international passengers' repurchase intentions and 'word-of-mouth' communications. The study also stated six practical implications for service management of airline system. At first, this study showed that service quality was a significant driver of passenger satisfaction and perceived value, which are directly related to passengers' behavioural intentions (Park et al., 2006). Secondly, the airlines system should make sure that providing higher service quality is worthwhile in a sense that passengers believed that the value is improved. Hence, the airlines can guarantee that the passengers' perception of value contributes to good levels of satisfaction. Third, the service operator in the airline industries should be able to manage the perceptions of passengers' ticket price because it influenced passengers' value perceptions, passenger satisfaction, airline image and passengers' behavioural intentions. Fourth,the airlines should recognize the trade-offs between service quality and ticket prices before developing their marketing strategies. It was suggested that the marketing strategies should be able to improve the passengers' value perceptions. Fifth, the airlines should have a unique image and attractiveness as compared to other airlines in order to attract new passengers or retain existing passengers. Finally, the most important element for airlines are to utilise their resources to improve passengers' future behavioural intentions on their services.

Study by Pantouvakis (2010) assessed the relative importance of various service-quality dimensions in explaining customer satisfaction, and examined whether the assessment is affected by the measurement instrument used. The data are collected from 434 passengers at the port of Piraeus in Greece. In Pantouvakis (2010) study, a new

Servicescape model for directly measuring the physical and the interactive features of a service is proposed and tested against the SERVQUAL. It was interesting to discover that SERVQUAL instrument failed to fully capture the role of “tangibles” in determining overall customer satisfaction in the service under examination. However, since the proposed instrument (“Servicescape”) is new and has not been previously developed or operationalised, several limitations are anticipated and more related research should be conducted to assess the relative importance of various service-quality dimensions in explaining customer satisfaction.

In Githui et al. (2010) public transport service attributes influencing overall passengers’ satisfaction were investigated in the city of Nairobi. From their study, the satisfaction level of public transport service was found to be significantly influenced by service quality, safety, travel cost and the systems’ performance perception. It was proposed that by improving the significant attributes, the public transport services usage and ridership will be enhanced.

The study by Irfan et al. (2011) investigated the passengers’ perceptions on the service quality of rail transport system between the major cities in Pakistan. In this study, a modified SERVQUAL instrument which consisted of eight service quality constructs (31 observed variables) were measured, namely, empathy, assurance, tangibles, timeliness, responsiveness, information system, food and safety and security were applied. The results indicated that only tangibles construct showed a positive and significant influence on passenger satisfaction. This is due to the lack of safety measure, lack of operational, poor information system and lack of comfort while travelling.

Lai and Chen (2011) explored public transit passengers’ behaviours by constructing a comprehensive model considering public transit involvement, service quality, perceived value, satisfaction, and behavioural intentions for Kaohsiung Mass Rapid Transit

(KMRT) in Taiwan. The findings revealed that all causal relationships are statistically significant. It was discovered that the passenger behavioural intentions or loyalty significantly rely on passenger satisfaction. In order to enhance customer satisfaction, service quality and perceived value of the public transit system should be addressed. Service quality is measured as passenger evaluations of the service attributes of public transit services, such as the general characteristics of the public transport system, terminals and stops, vehicles, and transport points (Tyrinopoulos and Antonious, 2008). Quality improvement and management, such as identifying those specific attributes about which passengers are most concerned and endeavoring to offer quality services, are prerequisites to obtaining passenger satisfaction. Based on their findings, the service attributes, i.e. vehicle safety, facility cleanliness, and complaint handling have significant influences on passenger behavioural intentions. In addition, the system should be able to provide passenger-value-oriented quality services to satisfy their passengers and thus increase word-of-mouth behaviour, and consequently customer loyalty. These findings can provide useful information for the KMRT in its efforts to prioritize the important service attributes and ensure its service quality meets or exceeds passenger expectations. However, offering better service quality is always costly, and such costs are frequently shifted to passengers through higher ticket prices, and these might offset any benefits that obtained.

Interestingly, research by Malik, (2012) in the service sector at Pakistan revealed that customer satisfaction is significantly related with perceived service quality and perceived value. The analysis was carried out using SERVQUAL instrument which was developed by Parasuraman et al, (1988). The results showed that after the inclusion of perceived value in the analysis, the strength of relationship between perceived service quality and customer satisfaction has increased, indicating that perceive value does act as partial mediating variable in the relationship between perceived service quality and customer satisfaction. The inclusion of perceived value variable explained 37.5% of the variance in dependent variable as compared to 9.4 percent variance in customer satisfaction and perceived service quality relationship. In addition, perceived value was found strongly correlated with satisfaction. This study shows that price is an important contributor in customer satisfaction in Pakistan.

Eboli and Mazzula (2012) proposed a tool for analysing passengers' perceptions in terms of satisfaction with railway services in the Northern Italy. In this study, a structural equation model is formulated to explore the impact of the relationship between global customer satisfaction and service quality attributes. The service quality attributes involved were safety, cleanliness, comfort, additional services, information, and personnel. It was discovered that service and cleanliness depicted the highest positive effect on service quality, with each attributes explained 25% of the sum of all the weights. It was interesting to find that safety (5.0%) was not considered as substantial regression weight as compared to other service quality attributes. In addition, additional services such as parking, facilities for disabled and bicycle transport on board as well as substitute services has no effect on Service Quality because the regression weight was not statistically significant. The findings from their study can be applied in the improvement strategies of other railways services of similar kind. Eboli and Mazzula (2012) also proposed that their model framework can be generalized for analysing any kind of service in order to provide cost effective solution to attain higher passenger satisfaction. However, a major concern arise from their model is the influences of each service attribute that could varied from one transit service to another and from one area or country to another. Therefore, the application of the model framework on the service quality attributes should be applied with careful consideration and attentive.

2.6.3 The Assessment on Public Transport System Traits

The assessment on public transport system traits involved the bus service and rail transit services. The assessment was referred to the evaluation on the factors that are highly importance to bus users and rail users while travelling by bus or rail transit. The important characteristics and priority values of related rail transit system traits were identified and tenable strategies could be implemented to improve the system. Several literatures which discussed on the importance levels of different rail transit system traits were reviewed in the following sub-sections

The study by Fillone et al., (2005) developed and compared three structural models for urban travellers doing work trips in the morning at Metro Manila. The three structural models were developed according to the users' types. There were (1) private car users' model, (2) public transport users with cars of their own or who have access to vehicles belonging to their households' model, and (c) captive public transport users who do not own a vehicle model. The analysis was carried out using Factor Analysis and SEM. The software used was LISREL. The comparison on the three models was then made regarding the differences in the significant variables of these three groups of travellers as they perceived their travel experience. The main concern was in identifying the important variables to car-owning but transit-using individuals that can be of significance when introducing travel demand management (TDM) measures that could encourage and attract car-using individuals to use public transportation (Fillone et al., 2005). The results of Fillone et al., (2005) study are important in the planning of new travel demand management (TDM) systems which will encourage the use of public transportation in Metro Manila. Although the developed models were not the best-fit models due to the limitation of the software that Fillone et al., (2005) used, which can be fit only 12 variables, several interesting interrelationship could be summarized. Three latent variables relationship was investigated in this study. Those latent variables were the socio-economic and demographic characteristics of the traveller, the travel experiences in terms of their travel time, travel cost and availability of companion while travel. The endogenous variable was the importance of the travel attributes, namely, total travel time, affordability of travel, comfort, convenience and accessibility , service reliability, and safety and security. For private car users' model, it was discovered that socio-demographic characteristics of the traveller showed positive relationship while car travel experience load negatively on the urban travel assessment. The service reliability, convenience and accessibility, and comfort were discovered as the important characteristics when using a car from home to workplace. For public transport-using but car-owning traveller, both the socio-demographic characteristic and the generalized cost of travel showed positive relation in urban travel assessment. The order, safety and security, convenience and accessibility and service reliability were discovered as the important characteristics which influenced the public transport users with vehicle ownership. However, for the captive public transport user model, the household socio-demographic characteristic as well as the travel generalized cost showed positive relationship in urban travel assessment. The order, safety and security, comfort, and service reliability are the important traits or attributes for captive public transport users when travelling with public transport.

The qualitative study by Beirao and Cabral (2007) in the metropolitan area of Porto, Portugal has highlighted that the possibility to shift among potential users, i.e. car users and public transport users influenced by the improvement of public transport image and whether the public transport service achieve the desired levels of performance. Beirao and Cabral (2007) also emphasized that service reliability, low frequencies of public transport services and lack of comfort will be a deterrent to users' because they perceived public transport service as an unfeasible alternative for their journey. Therefore, it was discovered that psychological constraints, perceptions and attitude of the users should be highly considered in mode choice research and market segmentation instead of consider only to socio-demographic characteristics.

The study by Gebeyehu and Takano (2007) explained the diagnostic evaluation of the public transportation mode shift in Addis Ababa, Ethiopia. Three bus condition parameters, namely, bus fee, bus convenience (boarding, in-bus crowd, bus steps and chair convenience etc.), and bus frequency were addressed. Based on their findings, 91.0% of the respondents' perceived bus was less costly when compared with other modes of transportation. However, in terms of convenience, most respondents found that travel by bus was less convenient as compared to other modes of transportation. Nevertheless, majority of the respondents reported that the public bus frequency was good, even though a significant number of respondents said that the bus frequency was low. The ordered logit model to examine travellers' perceptions of the bus condition, as a determining factor for their choice of bus transportation was developed to analyse the travellers' choice behaviour. The outcome from this study showed that travellers' perceptions of the three chosen bus condition aspects, namely, frequency, fare and convenience showed significant influence on the public transport mode shift.

The structural model to investigate the impact of bus transit aspects on global customer satisfaction was proposed by Eboli and Mazzulla (2007). The study was conducted among university students who used the urban bus service in the Southern Italy. The influenced of three exogenous variables on the global customer satisfaction (endogenous variables) were considered in their model. Those variables were (1) network design, (2) service planning and reliability and (3) comfort and other factors. It was discovered that service planning and reliability showed major effect on global customer satisfaction. Interestingly, Eboli and Mazzulla (2015) also investigated the relationship between global customer satisfaction and service quality attributes for rail transit service in Northern Italy. Seven service quality attributes were considered in the structural model. Those attributes were (1) safety, (2) cleanliness, (3) additional services, (4) information about the service, (4) personnel, (5) safety, (6) comfort and (7) service. 33 service quality attributes were used to explain the latent constructs. Based on the findings, information, cleanliness and service have the highest positive effect on the overall service quality and the average importance rate for each construct showed similar value (8.5-8.7). Interestingly, findings from the model suggested safety as the least important service quality attributes which contradicted to the rail users judgement that rated safety as the most important factor. Eboli and Mazzula (2015) also proposed that their model framework can be used to improve the railways services of a similar kind.

The interesting findings from Cantwell et al., (2009) revealed that public transport users were affected more by the crowded and congested at public transport terminals or stations as compared to the unreliability of the service in Dublin. This is because of increased invasion of their personal space and cramped, which leads to uncomfortable conditions (Cantwell et al., 2009). In addition, the satisfaction levels among public transport users were decreased for users' who travel in crowded or unreliable services and those who have long waiting time at stations or terminals. The long waiting time was related to services which were not running according to the schedule. The relationship of crowding and reliability revealed that the utility increases as crowding decreases and as reliability increases. The findings from the multinomial logit model revealed that both public transport users, namely, bus and rail users would be beneficial from an improvement in service reliability and a reduction in crowding. However, it was interesting to note that rail users would attain better benefit from a reduction in crowding and an improvement in reliability compared to bus passengers.

De Ona et al., (2013) proposed a methodology to evaluate the overall service quality of a bus transit service in Spain. Based on their findings, three latent constructs were identified to represent the bus service characteristics. These latent constructs were (1) Service, which referred to the attributes explaining the performance of the service, (2) Comfort, which referred to the attributes influencing comfort in the travel experience and (3) Personnel, which referred to the attributes related to staff behaviour. 11 bus transit service attributes were used to represent the constructs. The Service construct showed the major influence on overall service quality of bus transit service. In addition, the passengers were highly affected by the frequency and speed of the bus service. Meanwhile, the passengers were less sensitive to proximity and fare of the bus service. The finding from the structural model provides useful information on the bus service attributes which are of importance to them when they travel with bus.

The other public transport system traits namely, travel time, travel cost, reliability, safety, comfort, and convenience were also believed to be the factors that highly influence the travel behaviour among public transport users (Vanniarajan & Stephen, 2008; Tyrinopoulos & Antoniou, 2008; Friman & Felleson, 2009; Yannis & Georgia, 2008; Belwal & Belwal, 2010; Kamaruddin et al., 2012; Tippichai et al., 2010). Among all, travel time was found to be the most important trait for several urban cities throughout the world, for instance, Beijing, Bangkok, Kathmandu, Tokyo, and Kuala Lumpur as compared to other traits (Kamaruddin et al., 2012; Tippichai et al., 2010; Khalid et al., 2014) . In addition, it was found that one of the highly important factors in Tokyo was service reliability, convenience of service in Bangkok, and safety in Kathmandu and Beijing (Tippichai et al., 2010).

2.7 Chapter Summary

In this chapter, the relevant literature review for this research was summarized. At first, the factors influencing transit ridership and direct and indirect strategies to increase transit ridership based on Transportation Research Board (TRB), (2003), Vuchic, (2005) and Wibowo (2007) was presented. After that, the definition and concept of transit accessibility were discussed. The importance of improvement on accessibility to reach rail station was also discussed because good accessibility will determine whether travellers will consider shifting to public transport services. The summary of access profile showed that the increment in access cost, access time and access distance will influence their access mode to reach public transport services. Walking to public transport services was found as the dominant access mode for short distance. In this study, review on travel mode choice studies was also discussed. The use of travel mode choice models in various transport studies was also reviewed. The models have been widely used to predict the individual decision (choice of mode, route, etc.) as a function of any number of variables. The model can be used to estimate the number of people who likely to change their travel behaviour with respect to different scenario design. In this study, the discussion on travel mode choice included the influence of access cost, access time and access distance increment on shifting probability to public transport services. The use of SP and RP techniques in questionnaire design was also discussed. One of the issues in travel choice modelling is inertia effect. Therefore, the related literature which explained the influence of inertia effect on modal shift was revised. The related literature on the use of Importance-Performance Analysis method (IPA) to identify parameters or attributes that should be prioritized was also discussed. In addition, the review on Structural Equation Modelling Approach (SEM) which is used in developing the structural model was included. Finally, literature on the relationship of service quality and users' satisfaction as well as the assessment of public transport system traits was revised.

CHAPTER 3: RESEARCH FRAMEWORK AND METHODOLOGY

3.1 Introduction

This chapter describes the research methodology adopted in achieving the aim and objectives of the research. The methodological procedures are divided into five sections. First, the research framework of the study will be described. Second, the determination of mode choice variables for frequent rail transit users and private transport users will be explained. This is then followed by study area selection, questionnaire design, sampling procedures and collection of the data. Subsequently after that, the procedures to analyse each data will be explained, namely, (i) mode choice models of frequent rail transit users and private transport users under different hypothetical travel attributes scenarios, (ii) structural equation modelling approach and (iii) importance-performance analysis on different access modes indicators. Finally, to analyse the data, models will be constructed and from that, estimation will be made within the specifications, and its statistical significance will be stated.

3.2 Research Framework

The whole process to achieve the research objectives as highlighted in Chapter 1 was illustrated in research framework in Figure 3.1. Each major part of the work is discussed in dedicated sub-sections. The formulated research framework in Figure 3.1 was adapted from Sarantakos (2005) and was modified to suit this study. The research framework consisted of five stages and eight steps. The five stages were identification stage, development stage, operation stage, analysing stage and refinement stage.

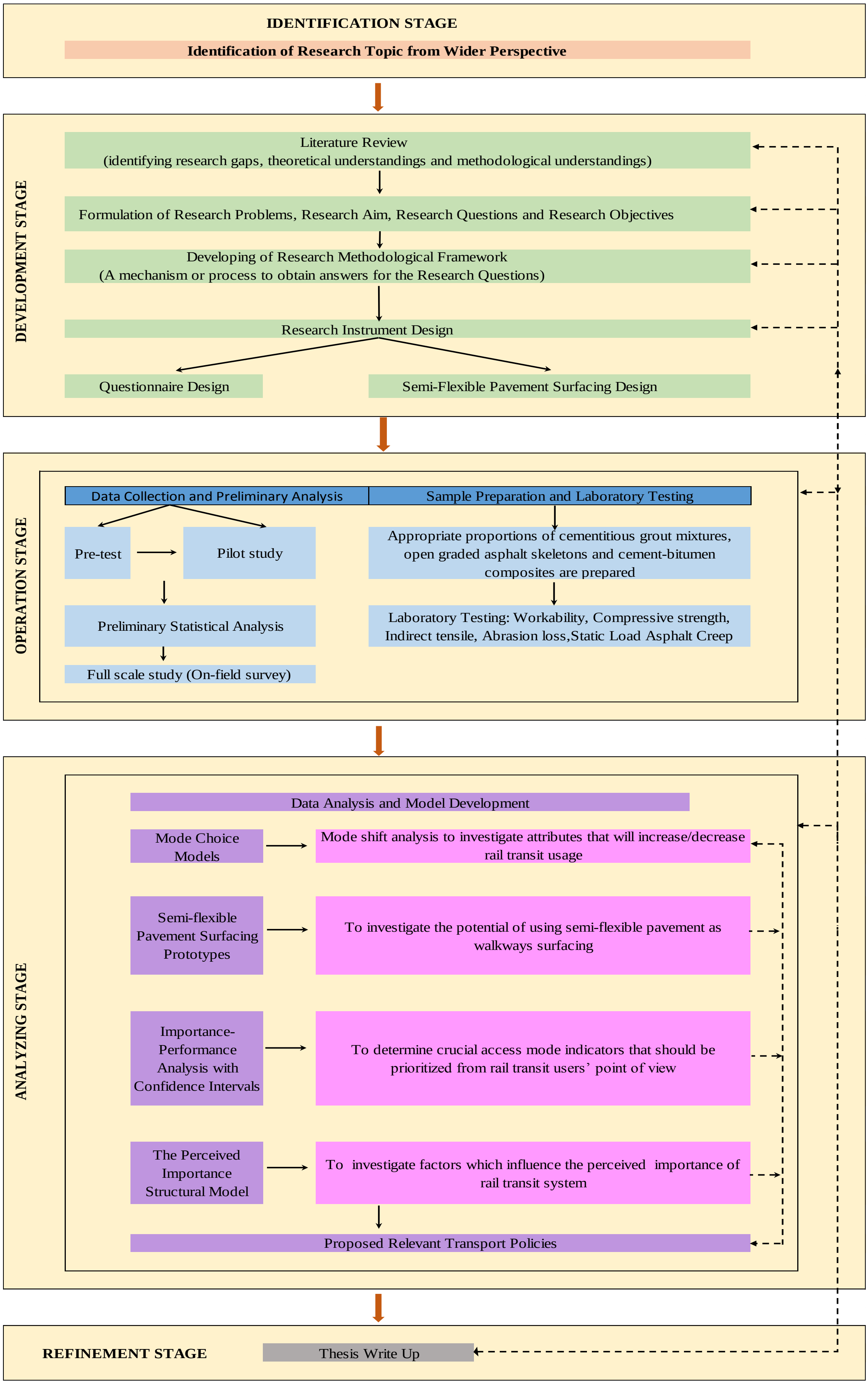

Figure 3.1: Research Framework

The research framework is start by identifying the research topic (identification stage). The current issues on the studies area were investigated. The selected topic was then refined by making it clear and specific. This is followed by development stage. In this stage, the relevant and related literature review was investigated and reviewed. The next step involved the formulation of research problems, research aim, research questions and research objectives. Then, the research methodological framework was developed. In this step, the mechanism or process to obtain answer for the research questions were developed. The next step is to develop research instrument design. Two research instrument designs were developed, i.e. (1) Questionnaire design and (2) Semi-flexible pavement surfacing design for walkways.

The third stage is the operation stage. In the operation stage, the data collection and preliminary analysis was carried out. The pre-test session, pilot study and preliminary analysis on the data was carried out prior to conducting the full scale study. The pre-test session was conducted to determine the strength and flaws in the survey questions concerning question format, content, wording and order. Pre-testing is critical for identifying questionnaire problems and was conducted on the focus group. Problems with question content include confusion of the overall meaning of the question, as well as misinterpretation of individual terms or concepts. Problems with how to navigate from question to question may result in missing data and frustration for both enumerators and respondents. Questionnaire formatting concerns are particularly relevant to self-administered questionnaires, and if unaddressed, may lead to loss of vital information. After all the responses were addressed from pre-test session, a pilot study was conducted. The findings from pilot study can be a guidance in the design and implementation of larger scale efficacy study (Leon, et al. 2011). During pilot study, practical problems that occurred are usually related to survey implementation rather than survey design. The preliminary analysis was then carried out to investigate and inspect whether the findings are viable and appropriate for analysis in relation to the study objectives. After the results from preliminary analysis was obtained, the full scale study was conducted. The data was collected through on-field survey. In addition, the sample preparations and laboratory testings on the semi-flexible pavement surfacing prototypes were involved in the operation stage. The appropriate proportions of cementitious grout mixtures, open graded asphalt skeletons and cement-bitumen composites (semi-flexible pavement surfacing prototypes) were prepared. After that, the suitability of the semi-flexible pavement surfacing as the walkways surfacing material were investigated based on certain criteria. The criteria were workability, compressive strength, indirect tensile stiffness modulus, abrasion loss and static load asphalt creep performance.

After the data compilation, the next stage was the analysis stage. In this stage, data analysis and model development was carried out. From the findings, relevant mode choice models, importance-performance analysis plots, the potential of using semi-flexible pavement as walkways surfacing and perceived importance structural model are developed and discussed. Based on the findings, relevant transport policies are proposed. Finally, the refinement stage is the final stage in the research framework. In this stage, the thesis was produced. The thesis was written with the aim to report the research findings, expanding the related knowledge and discussing the research topic more thoroughly.

3.3 Selection of Study Area

The study was carried out in Klang Valley area, Malaysia. The Klang Valley region spans across approximately 2,843 square kilometres (Land Public Transport Commision, 2013). Based on the 2010 census, the Klang Valley (KV) conurbation has a total population of over 6.3 million compared with 4.6 million in 2000 and 3.0 million in 1990 (Land Public Transport Commision, 2013). It was expected that the KV conurbation will be congested with a total population of 10.0 million in 2020. In addition, Klang Valley contributed around RM263 billion to the country's Gross National Income (GNI) which contributes to 30% of the nation's GNI in 2010. With only 20% of the national population, the contribution demonstrates the importance of KV to the nation's economic growth (Ministry of Federal Territories and Urban Wellbeing, 2014). It was anticipated that the increment of population growth for over 20 years, increasing numbers of high income among city dwellers, and rapid expansion of urban areas in Klang Valley (KV) will subsequently led to an increase in travel demand. With related to this study, the KV area was chosen as case study due to its high car ownership number and availability of the rail transit system.

As the most vital urban area in Malaysia, KV has one of the most modern public transportation systems in this region. It has a comprehensive network of buses, taxis, monorail, light rail transits and commuter trains that provide convenience and access to various parts of the cities and their surroundings. In this study, the urban rail transit service in Klang Valley is adopted due to its phenomenal growth in terms of economic and population for the last two decades. Up to the first quarter of 2015, the ridership numbers for LRT services (Kelana Jaya line, Ampang line), ERL services, KLIA Transit, KLIA Express and KL monorail are nearly 43.9 million, an increase of 4.7% as compared to the first quarter of 2014. Without doubt, rail usage is the fastest growing among all modes of urban public transportation according to ridership data from rail service operators. As a comparison, daily ridership for urban rail services rose 8.5% to 631,988 commuters in 2015 from 557,921 in 2011 (Ministry of Transport, 2015). As of 30th June 2016, the existing rail transit network in the KV is fairly extensive and has total distance coverage of covers 310.1 km of rail with 140 stations (Land Public Transport Commision, 2016).

The Government has also committed a significant allocation of RM70 billion to fund infrastructure costs to expand and improve the urban rail network. Currently, there are 8 main routes served the commuters in KV region as depicted in Figure 3.2 (Line 1 until Line 8). Line 10 and 11 in the figure showed the proposed Mass Rapid Transit (MRT) which is still under construction. The much anticipated Mass Rapid Transit (MRT) Line 1 from Sungai Buloh will be operational in phases. Phase 1 Sungai Buloh to Semantan will be operational by 31st December 2016, while the full line up to Kajang station will be operational in July 2017 (Land Public Transport Commision, 2016). MRT Line 2 with the total distance of 52.2 km spanning from Sungai Buloh - Serdang to Putrajaya is slated for completion in January 2022 (Land Public Transport Commision, 2016). Meanwhile, Line 12 in the figure, namely, LRT3 Line from Bandar Utama to Klang is expected to be completed in August 2020.

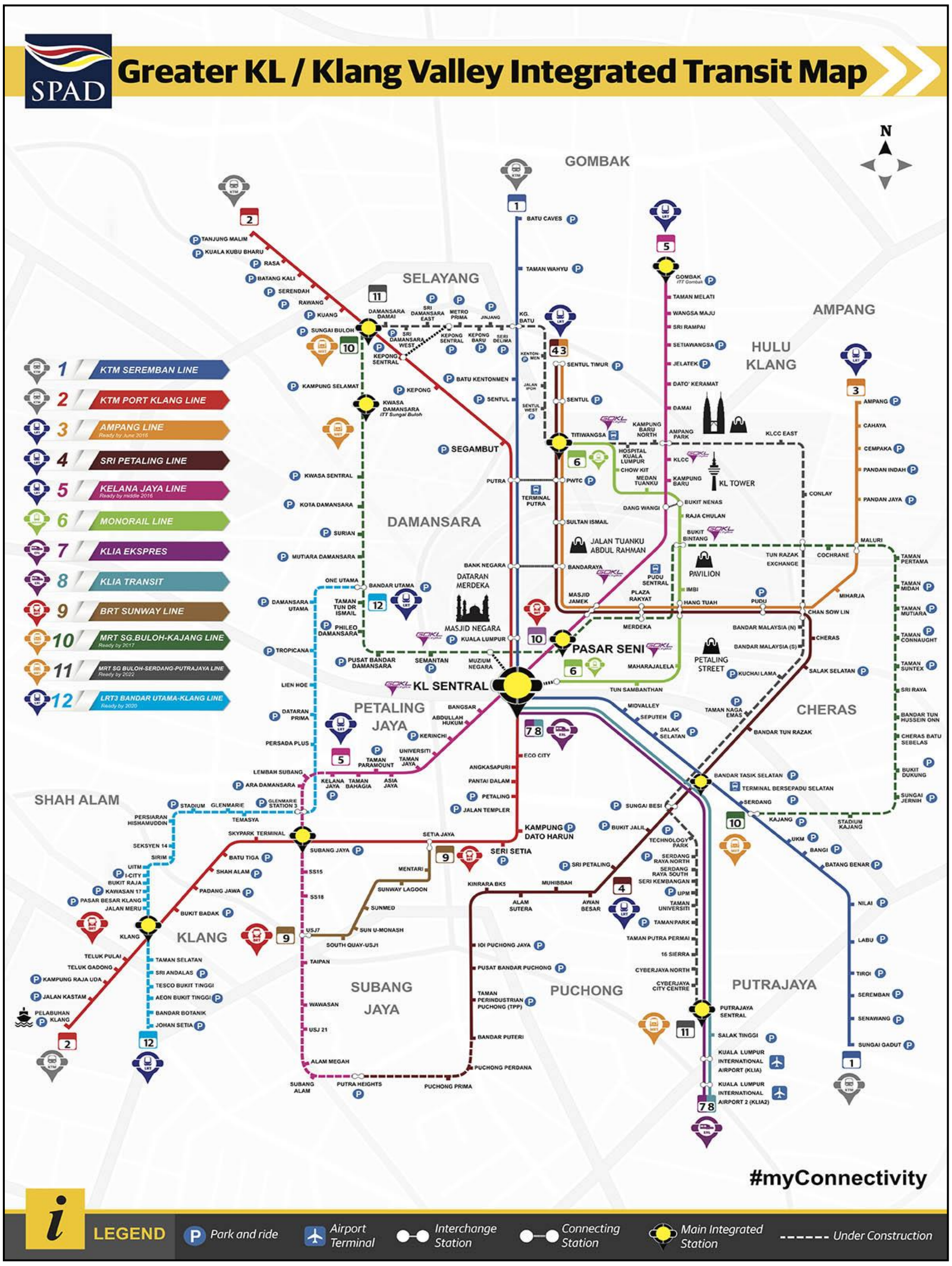

Figure 3.2: The Klang Valley Rail Transit Network

(Source: Land Public Transport Commission, 2016)

However, due to several drawbacks of public transport services and rapid changes of city dweller lifestyle, KV is facing a decline in public transport modal shares within 20 years period, i.e. from 37% (1990) to 17% (2010). The trip modal shares in KV using various public transport modes and private transports are exhibited in Figure 3.3.

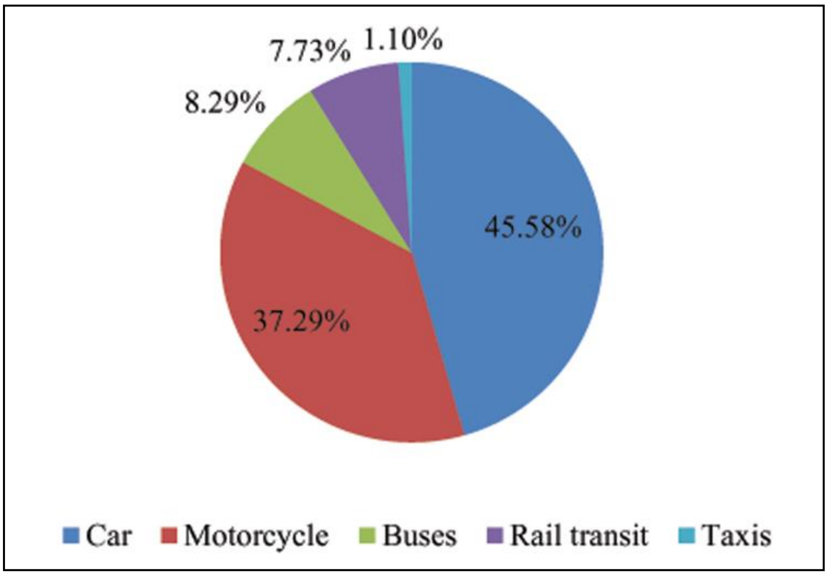

Figure 3.3: Trip Modal Shares in Klang Valley

It was depicted that about 83.0% of commuters in KV use private transport for their trips. Interestingly, about 7.73% commuters in KV use the rail service for their trips. This shows that travelling by rail transit is not regularly common and represents a major shift away from public transport to private transport use for daily travel in KV (Land Public Transport Commission, 2013; Performance Management and Delivery Unit, 2013). This situation has consequently created considerable pressure on the road network, which further caused traffic congestion and air pollution in KV areas. These issues have become prominent concern among citizens especially with the enormous growth of motorization in KV and highest numbers of roads and tolled highway in the world which will later lead to massive traffic congestion and persistent gridlock (Almselati et al., 2011;Onn, 2013). Without doubt, the urbanization spread in KV areas brings a strain to the city and populations. For instance, KV has 3.2 million private cars with an average of 30,000 cars per month. It was expected that the modal share of private cars will continue to rise and estimated to reach 7 million by the year 2020. The major roads in the city centre are closely approaching their usage capacity which indirectly causing longer travels time to reach one's destination. This will lead to lacking in productive due to road congestion and eventually cost the nation its competitiveness especially in its key economic corridor (Jemali, 2011; Performance Management Unit and Delivery Unit, 2014). As mentioned previously, the public transport modal share in KV (17.0% in 2010 and 25.0% in 2012) was lower as compared to other cities in the world, for instance Singapore, Hong Kong and London, where the public transport modal share are 64.0%, 74.0% and 90.0% respectively. According to Bachok et al. (2014), a modal split ratio of 50:50 between private and public transport shall be adopted as the city's mission for major urban centres. With related to study objectives, poor access to public transport especially to rail transit station was highlighted as an important factor of the Greater Kuala Lumpur / Klang Valley Master Plan (Land Public Transport Commission, 2013a), Urban Rail Development Plan (Land Public Transport Commission, 2013b) and Kuala Lumpur Structure Plan 2000. In Urban Rail Development Plan (Land Public Transport Commission, 2013b), accessibility from home to office or workplace has been mapped from both the perspectives of employers and residents across the region.

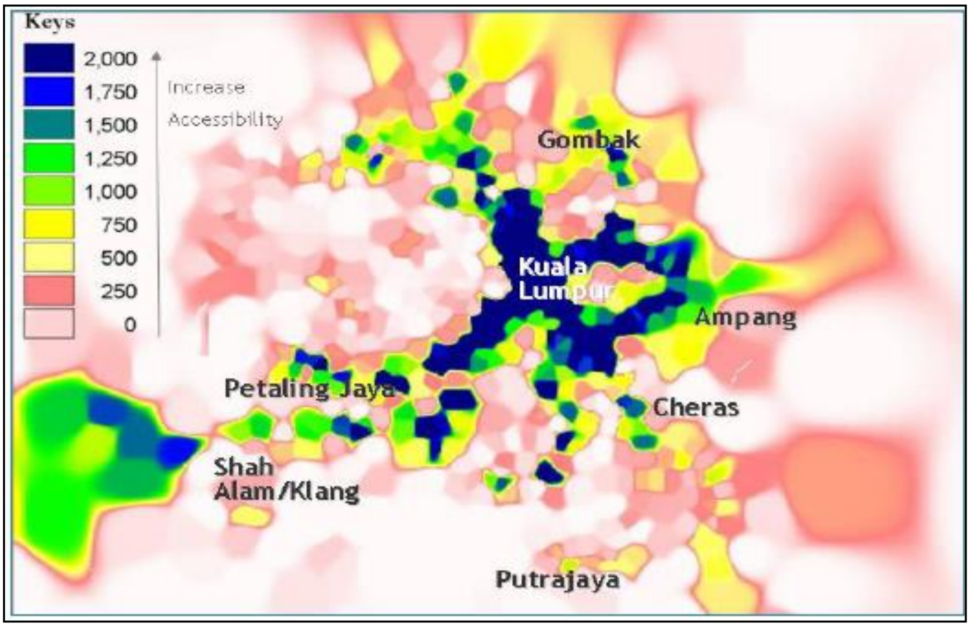

Figure 3.4: Accessibility Indicator-Number of Employees within a 75 Minutes Catchment (Land Public Transport Commission, 2013)

It was depicted in Figure 3.4 the number of employees within 75 minutes from their workplace or office by using Land Public Transport. Figure 3.4 mapped the Accessibility Indicator from the employer's perspective for any location in KV. The blue areas on the maps are those areas with the greatest accessibility and where employers have a much larger pool of labour to attract within 75 minutes (Land Public Transport Commission, 2013). It was indicated that the pink areas are those with much lower attractiveness as they have lower numbers of workers available within their catchment. The diagram also has screened out those in white which do not have significant employment in them (Land Public Transport Commission, 2013). In addition, the more accessible areas by Land Public Transport reflect the rail corridors within central Kuala Lumpur. It was depicted that there is a strong focus on the Light Rail Transit (LRT) corridors in the central area of Kuala Lumpur. Furthermore, the map also showed that areas to the north and west of the KV region generally have less accessibility than to the south. Therefore, for Land Public Transport, only those employers live nearby or close to a rail or LRT line will have good access to the workplace and similarly those residents living close to such lines have greater access to employment by Land Public Transport. With respect to the National Land Public Transport Master Plan 2013, the targeted modal share for public transport in the urban areas by 2030 is 40%. Based on the current trend, it seems possible if there is a continuous and comprehensive integrated system and network planning in order to achieve the target and the balanced shift. With the stated above reasons, KV was expected to be an excellent case study for this research.

3.4 Questionnaire Design

In this study, two types of respondents were addressed, namely, *frequent rail transit users* and *private transport users*. The frequent rail transit users refer to the commuters who are using rail transit system as their daily travel mode at least 8 times per week.

Whereas, private transport users refer to the commuters who are using private transport as their daily travel mode and at the same time have had experience travelling by rail in the past. The questionnaire for both respondents' was designed in a set of structured on-field survey questions, and the respondents' have to answer those questions which are related to their daily travel mode. The questionnaire survey for the study is presented in Appendix A. The brief questionnaire design used in this study is presented in Table 3.1. In this table, the connection between research questions, research objectives, research hypotheses and survey instruments are explained.

Table 3.1: Summary and Connection of Research Questions, Research Objectives, Research Hypotheses and Survey Instruments

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
1. How is the current accessibility condition to rail transit system in Klang Valley, Malaysia? 2. What are the factors that influence frequent rail users to travel by rail transit? 3. What are the factors that influence private transport users to travel by private vehicles?	RO1: To identify and discuss the access trip pattern to rail transit station as well as travel behavior of frequent rail transit users and private transport users in Klang Valley, Malaysia.	No research hypotheses involved. The data was analyzed through descriptive statistics analysis and parametric test.	**<u>Frequent Rail Transit Users Section in Questionnaire Survey</u>** **Part 1a : Respondent's Information**: To obtain data on the respondents' socio-demographic background. The information required are gender, ethnicity, nationality, age, marital status, employment, monthly income, license availability, vehicle ownership and vehicles per household. **Part 1b : Trip Information of Rail Transit user:** To obtain data on the daily travel information of frequent rail users. The information required are travel time, travel cost, travel distance, access cost, access time, access distance, access mode, travel purpose and number of trips per week. **Part 2a: Reasons of Using Urban Rail Transit System:** To investigate the reasons that make frequent rail users travel daily with rail transit.

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
			Private Transport Users Section in Questionnaire Survey **Part 1a: Respondent’s Information**: To obtain data on the respondents’ socio-demographic background. The information required are gender, ethnicity, nationality, age, marital status, employment, monthly income, license availability, vehicle ownership and vehicles per household. **Part 1c: Trip Information of Private Transport User**: To obtain data on the daily travel information of private transport users. The information required are travel time, travel cost, travel distance and number of trips per week. The private transport users are also require to provide information on their , access cost, access time, access distance, travel purpose and **Part 2a: Reasons of Using Private Transport:** To investigate the reasons that make private transport users travel daily with private vehicle.

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
4. How far will frequent rail transit users travel consistently using rail transit under different hypothetical travel increment scenarios and socio-demographic factors before they consider shifting to private transport?	RO2: To investigate the influence of different hypothetical travel increment scenarios and socio-demographic factors on the willingness of frequent rail transit users to travel consistently using rail and the potential of frequent rail transit users shifting to private transport.	HF-1: Significant relationship is assumed between socio-demographic characteristics and **access cost increment** with probability of shifting to private transport mode. HF-2: Significant relationship is assumed between socio-demographic characteristics and **access time increment** with probability of shifting to private transport mode. HF-3: Significant relationship is assumed between socio-demographic characteristics and **access distance increment** with probability of shifting to private transport mode. HF-4: Significant relationship is assumed between socio-demographic characteristics and **travel cost increment** with probability of shifting to private transport mode.	**<u>Frequent Rail Transit Users Section in Questionnaire Survey</u>** **Part 2b: Inclination of Frequent Rail Transit Users to Shift to Private Transport under Different Hypothetical Travel Scenarios**: To measure inclination of frequent rail transit users to shift to private transport under different hypothetical travel scenarios increment. The respondents’ have to answer questions from six travel scenarios as listed below; **Scenario 1**: Probability of shifting to private transport under increment of **access cost** scenarios. **Scenario 2**: Probability of shifting to private transport under increment of **access time** scenarios. **Scenario 3**: Probability of shifting to private transport under increment of **access distance** scenarios.

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
		HF-5: Significant relationship is assumed between socio-demographic characteristics and **travel time increment** with probability of shifting to private transport mode. HF-6: Significant relationship is assumed between socio-demographic characteristics and **rail frequency decrement** with probability of shifting to private transport mode.	**Scenario 4**: Probability of shifting to private transport under increment of **travel time** scenarios. **Scenario 5**: Probability of shifting to private transport under increment of **travel time** scenarios. **Scenario 6**: Probability of shifting to private transport under decrement of **rail frequency** scenarios.
5. How far will private transport users travel consistently using private vehicle under different hypothetical travel increment scenarios and socio-demographic factors before they consider shifting to rail transit?	RO3: To investigate the influence of different hypothetical travel scenarios increment and socio-demographic factors on the willingness of private transport users to travel consistently using private vehicle and the potential of private transport users shifting to rail transit.	HP-1: Significant relationship is assumed between socio-demographic characteristics and **fuel price increment** with probability of shifting to rail transit mode. HP-2: Significant relationship is assumed between socio-demographic characteristics and **travel cost increment** with probability of shifting to rail transit mode.	**Private Transport Users Section in Questionnaire Survey** **Part 3**: **Inclination of Private Transport Users to Shift to Rail Transit under Different Hypothetical Travel Scenarios:** To measure inclination of private transport users to shift to rail transit under different hypothetical travel scenarios increment. The respondents’ have to answer questions from seven travel scenarios as listed below;

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
		HP-3: Significant relationship is assumed between socio-demographic characteristics and **travel time increment** with probability of shifting to rail transit mode. HP-4: Significant relationship is assumed between socio-demographic characteristics and **access cost decrement** with probability of shifting to rail transit mode. HP-5: Significant relationship is assumed between socio-demographic characteristics and **access time decrement** with probability of shifting to rail transit mode.	**Scenario 1**: Probability of shifting to rail transit under increment of **fuel price** scenarios **Scenario 2**: Probability of shifting to rail transit under increment of **travel cost** scenarios **Scenario 3**: Probability of shifting to rail transit under increment of **travel time** scenarios **Scenario 4**: Probability of shifting to rail transit under decrement of **access cost** scenarios **Scenario 5**: Probability of shifting to rail transit under decrement of **access time** scenarios

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
		HP-6: Significant relationship is assumed between socio-demographic characteristics and **access distance decrement** with probability of shifting to rail transit mode. HP-7: Significant relationship is assumed between socio-demographic characteristics and **rail frequency increment** with probability of shifting to rail transit mode.	**Scenario 6**: Probability of shifting to rail transit under decrement of **access distance** scenarios **Scenario 7**: Probability of shifting to rail transit under increment of **rail frequency** scenarios
6. What are the access modes indicators that should be prioritized to improve the rail transit station accessibility?	RO4: To identify and investigate the current access modes indicators that are priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance and importance level.	➢ No research hypotheses involved. Each access mode used by frequent rail users was analyzed through Importance-Performance Analysis (IPA) Integrated with Confidence Intervals method.	**Frequent Rail Transit Users Section in Questionnaire Survey** **Part 3: Importance and Satisfaction Level of Access Modes Services:** To evaluate the importance and satisfaction level of accessibility indicators for different access modes. The frequent rail transit users have to answer those questions on the respective section which related to access modes that they used to reach rail station from home.

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
			Section A : For those who walk to reach rail station from home **Section B** : For those who take taxi to reach rail station from home **Section C**: For those who take bus to reach rail station from home **Section D**: For those who drive private transport (Park & Ride) to reach rail station from home **Section E**: For those who is being driven (drop-off) to reach rail station from home
7. How is the current performance of walking surface for pedestrian accessing the rail transit station?	RO5: To improve the walking surface for pedestrian accessing the rail transit station.	➢ No research hypotheses involved.	Laboratory investigation on the appropriate material for walking surface is proposed.
8. Which rail transit traits are priority and important to commuters when travelling by rail?	RO6: To evaluate the rail transit system traits that is of importance and priority to frequent rail users.	For the observed variables, the assumptions (or hypotheses) are as follows: *HI-1: A frequent rail user has a higher tendency to believe that rail safety is a priority when travelling with the rail transit system.*	**Part 4c: Perceived Importance of Rail Transit System:** To evaluate the significant or priority level of rail transit system traits or attributes among frequent rail transit users in developing a prominent rail transit system.

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
		HI-2: A frequent rail user has a higher tendency to believe that comfort and convenience is a priority when travelling with the rail transit system. *HI-3: A frequent rail user has a higher tendency to believe that service frequency and reliability is a priority when travelling with the rail transit system.* *HI-4: A frequent rail user has a higher tendency to believe that access to the rail station is a priority when travel with the rail transit system.* *HI-5: A frequent rail user has a higher tendency to believe that total travel cost is a priority when travelwith the rail transit system.* *HI-6: A frequent rail user has a higher tendency to believe that total travel time is a priority when travel with rail transit system*	

‘Table 3.1, continued’

Research Questions	Research Objectives	Research Hypotheses	Survey Instruments
9. What are the variables or factors which influence the perceived importance of rail transit system?	RO7: To develop the structural equation model for perceived importance of rail transit system.	The following respective hypothesis statements are constructed for the latent variables: *H1: Rail users’ travel experience has a significant causal effect on the perceived importance of rail transit system traits.* *H2: Rail users’ travel experience has a significant causal effect on rail users’ satisfaction.* *H3: Rail users’ travel experience has a significant causal effect on the perceived service quality of rail transit system.* *H4: Perceived service quality has a significant causal effect on the perceived importance of rail transit system traits.* *H5:Perceived service quality has a significant causal effect on rail users’ satisfaction.* *H6: Rail users’ satisfaction has a significant causal effect on the perceived importance of rail transit system traits*	**Frequent Rail Transit Users Section in Questionnaire Survey** **Part 4a: Rail Transit Users Satisfaction:** To investigate and evaluate frequent rail users’ perception and judgment on rail transit service performance. **Part 4b: Perceived Service Quality of Rail Transit System:** To investigate and evaluate the effectiveness of rail transit services. **Part 4c: Perceived Importance of Rail Transit System:** To evaluate the significant or priority level of rail transit system traits or attributes among frequent rail transit users in developing a prominent rail transit system. (based on Fillone, 2005) **Part 1b: Rail Users’ Travel Experience**: To identify and determine daily travel information of frequent rail transit users (based on Fillone, 2005)

The survey instruments listed in Table 3.1 will be explained in hereafter subsections.

3.5 The Survey Instrument

In this study, the survey instrument referred to a questionnaire to present a standard set of questions and response choices. Although there were two different respondents i.e. frequent rail transit users and private transport users, the respondents were answered their respective questions in the same questionnaire survey. In this study, the survey instruments in the questionnaire were designed using the revealed preference (RP) and stated preference (SP) methods. The questionnaire was validated by the experts and researchers in the field of transportation planning and engineering. The revealed preference (RP) survey instrument questions and stated preference (SP) survey instrument questions were explained in the subsequent subsections.

3.5.1 Revealed Preference (RP) Survey Instrument Questions

The revealed preference (RP) framework in questionnaire design was exhibited in Figure 3.5.

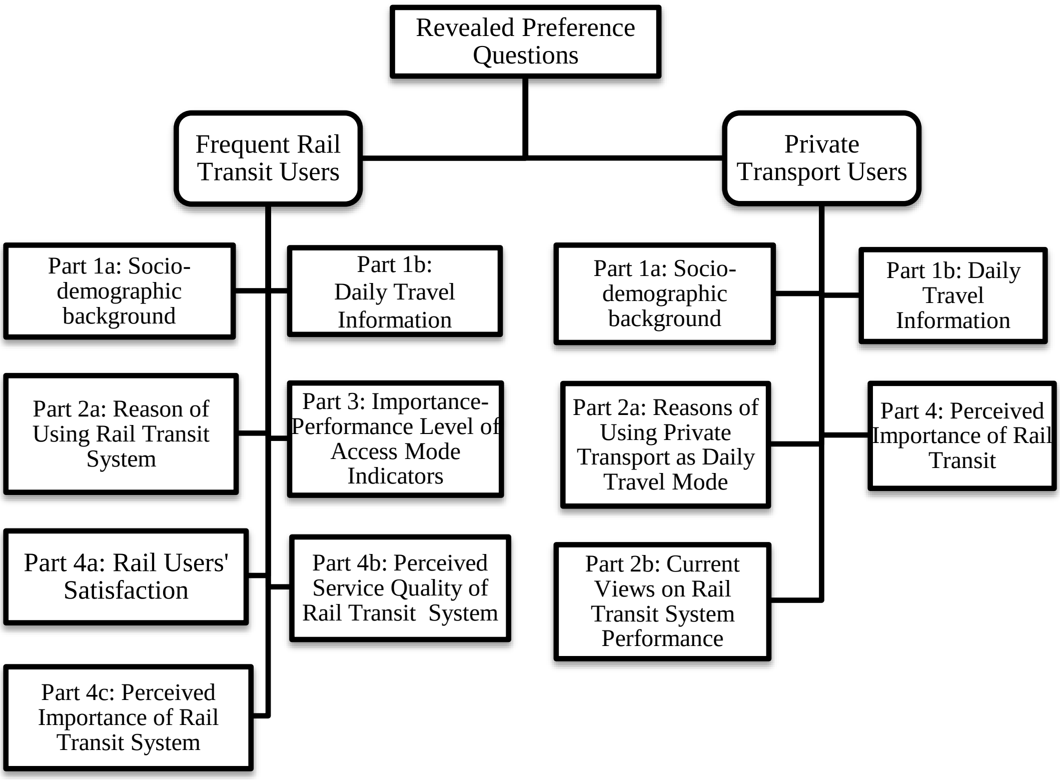

Figure 3.5: Revealed Preference (RP) Framework in Questionnaire Design

The RP questions were constructed to attain data on the current travel behaviour and respondents' socio-demographic background. Both respondents have to answer the demographic and socio-economic data in Part 1a. The characteristics of socio-demographic economic for each traveller (frequent rail users and private transport users) were similar which included their gender, ethnicity, nationality, age, marital status, employment, monthly income, availability of license, vehicle ownership, vehicles per household and travel purpose. Each socio-demographic economic variable and coding was defined in Table 3.2 below.

Table 3.2: Socio-Demographic Variables

Characteristic	Level	Characteristic	Level
Gender	0 = Male 1 = Female	*Licensed driver*	0 = No 1 = Yes
Ethnicity	1 = Malay 2 = Chinese 3 = Indian 4 = Other	*Availability of vehicle*	Continuous data
Age	1 = 18–24 2 = 24–30 3 = 31–40 4 = 41–50 5 = 51–60 6 = > 60	*Vehicles per household*	Continuous data
Highest education	1 = Primary/Secondary School 2 = Pre-University/Diploma 3 = Degree 4 = Postgraduate (Master/PhD)	*Travel purpose*	0 = Work 1 = Other purpose (education/recreation/ social)
Job status	1 = Student 2 = Pensioner/Housewives 3 = Blue collar jobs 4 = White collar jobs 5 = Self-employed/Businessman 6 = Management/Executive 7 = Professional	*Monthly income*	1 = ≤ RM1000 2 = 1001–2000 3 = 2001–3000 4 = 3001–4000 5 = 4001–5000 6 = ≥ 5001
Daily travel mode	0 = Rail transit 1 = Private transport	*Number of trips (per week)*	1 = 8–9 trips 2 = 10–11 trips 3 = 12 trips

In this study, the socio-demographic economic variables were also included and treated as explanatory variables in the development of travel mode choice preference analysis. This study designed six level of age group to differentiate the respondents' financial capability. The first group, aged 18-24 years old, are mostly a group of students with less or without financial capability; the second group, aged 24-30 years old includes those who are most likely to have a junior position in their job; the third, fourth and fifth groups, aged 31-60 years old includes those who are most likely have a senior position in their job and the last group, aged 61 years old and above are those who are retiree. There were four levels of education that were designed namely, primary/secondary school, pre-university/diploma, degree and higher degree levels. In this study, they were four levels of occupation groups that were designed. The occupation level was arranged according to the increment of income. The monthly income levels was categorized in six levels;

starting from monthly income group, 1 = less than RM1000 until group 6 = equal or more than RM5000 per month. There were two major travel purposes that were designed, namely work and other purpose (education/recreation/social). Previously, there were three groups of travel purpose that were considered, but for the purpose of travel mode choice preference analysis, the respondents were arranged in two groups. The number of trips per week was referred to trip frequency from origin to destination including their return trip by rail transit or private transport in a week. In addition, the respondents' were also asked about their driving license availability and vehicle ownership. The respondents were also responded the vehicles per household in a continuous data. The respondents were then have to answer questions separately according to their daily travel mode namely 0 = rail transit and 1 = private transport. Both respondents also need to answer the travel characteristics questions which referred to their current daily travel information in Part 1b. Trip information questions included the travel time, travel cost, travel distance, access cost, access time, access distance and etc. The travel characteristics of frequent rail users and private transport users were defined in Table 3.3 below.

Table 3.3: Travel Characteristic Variables

Travel Characteristics of Frequent Rail Transit Users	
Variables	Category
Travel origin and final destination	1. Ampang Jaya 2. Hulu Selangor 3. Kajang 4. Klang 5. Kuala Lumpur 6. Kuala Selangor 7. Petaling Jaya 8. Refused to answer 9. Sabak Bernam 10. Selayang 11. Sepang 12. Seremban 13. Shah Alam 14. Subang Jaya
Residential area	1. Klang Valley 2. Outside Klang Valley
Access mode from home to station	1. Walking 2. Taxi

	3. Bus 4. Park and Ride 5. Pick-up/Drop-off
Access station from home	Continuous data
Access station from office/workplace/university	Continuous data
Rail transit system that you use frequently	1. LRT 2. STAR 3. KTM Komuter 4. KL Monorail 5. KLIA Transit
Rail transit system that you satisfied much	1. LRT 2. STAR 3. KTM Komuter 4. KL Monorail 5. KLIA Transit
Access cost from home to station (*include/exclude walking*)	6. RM0-RM1.90 7. RM2.00-RM3.90 8. RM4.00-RM5.90 9. RM6.00-RM7.90
Access time from home to station	1. 0-10 minutes 2. 11-20 minutes 3. 21-30 minutes 4. 31-40 minutes 5. 41-50 minutes
Access distance from home to station	1. 0-500m 2. 501-1000m 3. 1001-1500m 4. 1501-2000m 5. More than 2000m
Overall travel cost from home to final destination (including return trip)	6. RM0-RM1.90 7. RM2.00-RM3.90 8. RM4.00-RM5.90 9. RM6.00-RM7.90 10. RM8.00-RM9.90 11. RM10.00-RM11.90 12. RM12.00-RM13.90 13. RM14.00-RM15.90 14. RM16.00-RM17.90 RM18.00-RM19.90
Overall travel time from home to final destination (including return trip)	1. 11-20 minutes 2. 21-30 minutes 3. 31-40 minutes 4. 41-50 minutes 5. 51-60 minutes 6. 61-70 minutes 7. 71-80 minutes 8. 81-90 minutes 9. 91-100 minutes 10. > 100 minutes

‘Table 3.3, continued’

Variables	**Category**
Overall travel cost from home to final destination (including return trip)	15. RM0-RM1.90 16. RM2.00-RM3.90 17. RM4.00-RM5.90 18. RM6.00-RM7.90 19. RM8.00-RM9.90 20. RM10.00-RM11.90 21. RM12.00-RM13.90 22. RM14.00-RM15.90 23. RM16.00-RM17.90 24. RM18.00-RM19.90
Overall travel time from home to final destination (including return trip)	11. 11-20 minutes 12. 21-30 minutes 13. 31-40 minutes 14. 41-50 minutes 15. 51-60 minutes 16. 61-70 minutes 17. 71-80 minutes 18. 81-90 minutes 19. 91-100 minutes 20. > 100 minutes
Overall travel distance from home to station (including return trip)	1. 0-10km 2. 11-20km 3. 21-30km 4. 31-40km 5. More than 40km
Available alternative	1. No alternative 2. Bus 3. Taxi 4. Private transport
Travel Characteristics of Private Transport Users	
Questions on daily travel information when travelling by private transport	
Frequency using private transport per week (including the return trips)	1. ≥ 10 trips 2. 8-9 trips
Travel origin and final destination	1. Ampang Jaya 2. Hulu Selangor 3. Kajang 4. Klang 5. Kuala Lumpur 6. Kuala Selangor 7. Petaling Jaya 8. Refused to answer 9. Sabak Bernam 10. Selayang 11. Sepang 12. Seremban 13. Shah Alam

‘Table 3.3, continued’

Variables	Category
	14. Subang Jaya
Residential area	1. Klang Valley 2. Outside Klang Valley
Overall travel cost from home to final destination (including return trip)	1. RM0-RM1.90 2. RM2.00-RM3.90 3. RM4.00-RM5.90 4. RM6.00-RM7.90 5. RM8.00-RM9.90 6. RM10.00-RM11.90 7. RM12.00-RM13.90 8. RM14.00-RM15.90 9. RM16.00-RM17.90 10. RM18.00-RM19.90 11. ≥ RM20.00
Overall travel time from home to final destination (including return trip)	1. 0-10 minutes 2. 11-20 minutes 3. 21-30 minutes 4. 31-40 minutes 5. 41-50 minutes 6. 51-60 minutes 7. 61-70 minutes 8. 71-80 minutes 9. 81-90 minutes 10. 91-100 minutes 11. 101-110 minutes 12. 111-120 minutes 13. 121-130 minutes 14. 131-140 minutes 15. 141-150 minutes 16. 151-160 minutes 17. > 160 minutes
Overall travel distance from home to station (including return trip)	1. 0-10km 2. 11-20km 3. 21-30km 4. 31-40km 5. More than 40km
Available alternative	1. No alternative 2. Bus 3. Taxi 4. Private transport
Questions on daily travel information when travelling by rail transit based on private transport users experience	
Journey frequency using rail	1. Once a month 2. Seldom use 3. Never use
Access station from home	Continuous data
Access station from office/workplace/university	Continuous data
Travel purpose	Continuous data

'Table 3.3, continued'

Variables	Category
Access mode from home to station	1. Walking 2. Taxi 3. Bus 4. Park and Ride 5. Pick-up/Drop-off
Access cost from home to station (include/exclude walking)	1. RM0-RM1.90 2. RM2.00-RM3.90 3. RM4.00-RM5.90 4. RM6.00-RM7.90 5. RM8.00-RM10.00
Access time from home to station	1. 0-10 minutes 2. 11-20 minutes 3. 21-30 minutes 4. 31-40 minutes 5. 41-50 minutes
Access distance from home to station	1. 0-500m 2. 501-1000m 3. 1001-1500m 4. 1501-2000m 5. More than 2000m
Overall travel cost from home to final destination using rail (including return trip)	1. RM0-RM1.90 2. RM2.00-RM3.90 3. RM4.00-RM5.90 4. RM6.00-RM7.90 5. RM8.00-RM9.90 6. RM10.00-RM11.90 7. RM12.00-RM13.90 8. RM14.00-RM15.90 9. RM16.00-RM17.90 10. RM18.00-RM19.90 11. ≥ RM20.00
Overall travel time from home to final destination using rail (including return trip)	1. 0-10 minutes 2. 11-20 minutes 3. 21-30 minutes 4. 31-40 minutes 5. 41-50 minutes 6. 51-60 minutes 7. 61-70 minutes 8. 71-80 minutes 9. 81-90 minutes 10. 91-100 minutes 11. 101-110 minutes 12. 111-120 minutes 13. 121-130 minutes 14. 131-140 minutes 15. 141-150 minutes 16. 151-160 minutes 17. > 160 minutes
Overall travel distance from home to station using rail (including return trip)	1. 0 -10km 2. 11-20km 3. 21-30km 4. 31-40km 5. More than 40km

However, in Part 1b, instead of answering their current travel information, the private transport users also have to answer additional questions on their travel information experiences when using rail. The questions included journey frequency using rail that the private transport users experienced, access station, access mode use, travel purpose, access cost, access time, access distance and etc. Both respondents were then need to answer respective questions of Part 2 until Part 4 according to their travel mode. In relation to the study objectives, the frequent rail users were asked to rate the list of reasons that make them travel daily with rail transit as compared to private transport in Part 2a. Based on the literature and findings from the pilot study (Steg, 2003; Steg, 2005; Wibowo, 2007; Kamba et al., 2007), twelve reasons were considered. The reasons were shorter travel time, reliability, safety, affordability, convenience and comfort, accessibility, unavailability of vehicle, closer access distance, closer egress distance, availability of park and ride facilities, level of stressfulness and environmental issues awareness. The frequent rail users were asked to rate these reasons with a score range from 1, "strongly disagree" to 5, "strongly agree". The frequent rail transit users were also asked to state any other reasons that make them using rail transit as daily travel mode. The variables to measure the reasons of using rail transit system as daily travel mode were tabulated in Table 3.4 below.

Table 3.4: Variables to Measure the Reasons of Using Rail Transit System as Daily Travel Mode

Factors/Reasons	1 strongly disagree	2 Disagree	3 Unsure	4 Agree	5 Strongly agree
1. I am using rail transit because it is faster.					
2. I am using rail transit because the service is reliable.					

‘Table 3.4, continued’

Factors/Reasons	1 strongly disagree	2 Disagree	3 Unsure	4 Agree	5 Strongly agree
3. I am using rail transit because it is safe and secure.					
4. I am using rail transit because the travel cost is cheaper.					
5. Using rail transit is convenient and comfortable (clean, air cond., etc).					
6. It is easy/convenient to access rail transit station from my home.					
7. I don’t have available vehicle for my daily works.					
8. My workplace/office/school/ university is close to rail transit station.					
9. My home is close to rail transit station.					
10. The park and ride facilities are available in the station.					
11. Less stressful than other modes (not crowded, not congested).					
12. I am concern about environmental issues (e.g. global warming, pollution and etc.)					
13. Other, please specify:					

The private transport users who have experiences travelling with rail were asked to rate the reasons that make them travel daily with private transport as compared to rail transit in Part 2a. There were 13 factors that might be the influential reasons of the travellers using private transport as their travel mode choice. These factors were far access distance, far egress distance, higher total cost of rail transit, longer travel time, desirable routes outside rail coverage, no appropriate access modes facilities, convenient and comforts, reliability, the needs for vehicle for working purposes, flexibility, availability of vehicles to use, more transfer when using rail and security against crimes on train and at station. The private transport users were asked to rate the reasons with a score range from 1 "strongly disagree" to 5 "strongly agree". The variables to measure the reasons of using private transport as daily travel mode were tabulated in Table 3.5 below.

Table 3.5: Variables to Measure the Reasons of Using Private Transport as Daily Travel Mode

Factors/Reasons	**1 Strongly disagree**	**2 Disagree**	**3 Unsure**	**4 Agree**	**5 Strongly agree**
1. The rail station is too far from my home.					
2. My office/university/school is too far from the rail station.					
3. The total travel cost using private transport is cheaper than rail transit.					
4. The total travel time of using rail transit is longer than private transport.					
5. The desirable routes are not covered by rail transit.					
6. The rail transit station is difficult to access (no proper walking path, too many road crossings and etc.)					
7. It is convenient and comforts to use my own transport (not crowded, air cond.)					
8. The rail transit service is not reliable (train is not punctual, not come on schedule).					
9. I need my vehicle for working purpose (need to carry equipment, easy to mobile).					

'Table 3.5, continued'

Factors/Reasons	1 Strongly disagree	2 Disagree	3 Unsure	4 Agree	5 Strongly agree
10. More flexible to plan my time and journey if I use my own transport.					
11. Inconvenient because there is no direct route to my office/university. I need to do more transfers until I reach my workplace/ university.					
12. I have my own transport, so I don't think that I need to use rail transit as my travel mode.					
13. I feel safe using my own transport.					
14. Other, please specify:					

In frequent rail transit users' questionnaire section, the importance and performance level of each accessibility indicator for different access mode was measured in Part 3. Based on the literature and pilot study findings, there were five major access modes that were used by frequent rail transit users to access rail. The five major access modes were walking, bus, taxi, park and ride and drop-off. The list of 37 accessibility service quality of access mode were constructed based on several literatures (Wibowo, 2005; Wibowo, 2007; Iseki & Taylor, 2010; Das et al., 2013) and researcher's observation to several rail transit stations in Klang Valley. The accessibility indicators for each access mode is tabulated in Table 3.6 below.

Table 3.6: Accessibility Indicators for Each Access Mode

Code	Access Mode Indicators
Section A : For Those Who Walk to Rail Station	
W1	Walking distance from home to station (access distance)
W2	Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)
W3	Number of road crossings and delays
W4	Number of stairs or slopes to climb (ascending and descending steps).
W5	Crowded along walkways
W6	Risk of traffic accident
W7	Directness of walking path
W8	Walkaways characteristic (width, surface quality, surface material, etc.)
W9	Facilities toward disabled passengers (ramp for wheelchair, etc.)
W10	Security along the way to station
Section B : For Those Who Take Taxi to Rail Station	
T1	Access fare from home to station
T2	Access time from home to station
T3	Service reliability of the taxi (frequent, punctuality, etc.).
T4	Convenient and comfort in the taxi (cleanliness, air-cond. comfort on seat, flexibility to change route, etc.).
T5	Security concerns and safety issues (driving speed, reckless driving, vehicle condition, security against crime during day and night, etc.).
T6	Customer service and driver behaviour (driver's courtesy, good PR., complaints administration, etc.).
T7	Information on driver registration/passenger service vehicle.
T8	Facilities toward disabled passengers.
Section C: For Those Who Take Bus to Rail Station	
B1	Access fare from home to station
B2	Access time from home to station
B3	Service reliability of the bus (frequent, punctuality, daily operation hours, waiting time, etc.).
B4	Convenient and comfort in the bus (number of stops to pick-up/drop-off passengers along the way, cleanliness, air-cond. seat availability, level of noise, level of crowd, directness of route, etc.).
B5	Security concerns and safety in the bus (driving speed, reckless driving, vehicle condition, security against crime during day and night, etc.).
B6	Customer service and driver behaviour (driver's courtesy, complaints administration, etc.).
B7	Information on service schedule/maps at the bus stops.
B8	Facilities toward disabled passengers.
Section D: For Those Who Drive Private Transport (Park & Ride) to Rail Station	
P1	Total fuel consumption from home to station
P2	Access time from home to station
P3	Availability of parking space (adequate and convenient to park)
P4	Parking fee in the station
P5	Security concerns and safety issues (guarded parking space, etc.)
P6	Facilities toward disabled passengers
Section E: For Those Who is Being Driven (Drop-Off) to Rail Station	
D1	Drop-off area

‘Table 3.6, continued’

Code	Access Mode Indicators
Section E: For Those Who is Being Driven (Drop-Off) to Rail Station	
D2	Temporary waiting area.
D3	Access time from home to station.
D4	Safety issues (waiting and drop-off time)
D5	Facilities toward disabled passengers

Based on Table 3.6, each service quality elements or accessibility indicators was coded according to access mode type. For instance, code W1 until W10 for walking, code T1 until T8 for taxi mode etc. For walking mode, ten accessibility service quality elements or indicators were measured through importance and satisfaction level. The second section was for taxi mode with eight accessibility service quality elements, eight accessibility service quality elements for bus mode in the third part, six accessibility service quality elements were measured for park and ride mode in the fourth part and five accessibility service quality elements were measured for drop-off mode in the last part. One of the important elements which was not highlighted or less focused in past studies was accessibility for people with disability (Das et al., 2013; Grujicic et al., 2014). In this study, the satisfaction and importance level of accessibility for people with disability element was included in each access mode section. Throughout this study, the frequent rail users provided an assessment on satisfaction and importance level for all 37 accessibility service quality elements. The satisfaction and importance level was graded using Likert scale, from 1 = *not at all satisfied/not at all important*, 2 = *slightly satisfied/slightly important*, 3 = *moderately satisfied/moderately important*, 4 = *very satisfied/very important* and 5 = *extremely satisfied/extremely important*. More description on each attributes and methodology to analyse each access mode are explained in Section 3.16.

In final section of frequent rail transit users questionnaire, three survey instruments were designed, namely, Part 4a, Part 4b and Part 4c. The input from these three questions (Part 4a, Part 4b and Part 4c) will be used in the Structural Equation Modelling (SEM) analysis as presented in Section 3.13. In Part 4a, the frequent rail transit users were asked specifically about their satisfaction towards rail transit system services based on their experiences. In addition, private transport users were asked about similar question on their satisfaction when travelling by rail in their questionnaire section (Part 2b). Although the private transport users have less experience using rail, it was significant to investigate their respond in order to improve and enhance the rail transit system performance which will contribute to the possibility of them using rail transit more frequently in the future. The variables measured in Part 4a: Rail Users' Satisfaction (frequent rail transit users section) and in Part 2b (private transport users section) is tabulates in Table 3.7 below.

Table 3.7: The Variables in Rail Users' Satisfaction Measurement

Variables	**Satisfaction/Performance Level**				
	1 *Very poor*	**2** *Poor*	**3** *Fair*	**4** *Good*	**5** *Very good*
1. Facilities at rail transit station (ticket machine, toilet, disable facilities, etc.)					
2. Safety at station and inside rail transit					
3. Comfortability at station and inside rail transit					
4. Customer service and management of complaints					
5. Rail frequency (number of trains arrive in one hour)					
6. Rail fare (ticket price)					

Six variables were measured in rail users' satisfaction which was designed based on several kinds of literature (Wibowo, 2007; Iseki & Taylor, 2010; Das et al., 2013). The variables in rail users' satisfaction was graded using Likert scale, namely, 1 = *Very poor*, 2 = *Poor*, 3 = *Fair*, 4 = *Good* and 5 = *Very good*. More discussion rail users' satisfaction are explained in Section 3.16.

In Part 4b, the frequent rail transit users were asked specifically about their perceptions on service quality of rail transit system. The variables measured in Part 4b: Perceived Service Quality is tabulated in Table 3.8 below.

Table 3.8: The Variables in Perceived Service Quality Measurement

Variables	**1** *Strongly disagree*	**2** *Disagree*	**3** *Neutral*	**4** *Agree*	**5** *Strongly agree*
1. Travel with rail transit is less stressful					
2. It is easy to access rail transit station from my home.					
3. I feel comfortable when using rail transit (clean, air conditioned etc.).					
4. I feel safe and secure when travelling with rail transit.					
5. The train service is reliable.					
6. The train arrives on time.					

There were six variables used to measure the perception on service quality of rail transit system. The variables were also designed based on several literatures (Steg, 2003; Wibowo & Chalermpong, 2007; Redman, et al., 2013).The variables in perceived service quality was graded using 5-Likert scale, namely, 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree* and 5 = *Strongly agree*. More discussion on perceived service quality is explained in Section 3.14.2.

In the final part of both questionnaire sections, namely Part 4c in the frequent rail users section and Part 3 in the private transport users section, they were asked to rate the level of importance for each listed rail transit traits based on their perception and experiences. The variables measured in Part 4c: Perceived Importance of Rail Transit System is tabulated in Table 3.9 below.

Table 3.9: The Variables in Perceived Importance of Rail Transit System

Variables	**1** *Not at all Important*	**2** *Slightly Important*	**3** *Moderately Important*	**4** *Very Important*	**5** *Extremely Important*
1. Safety again crimes on train and at station.					
2. Service frequency and reliability of rail transit system (train come on schedule, punctuality).					
3. Convenient and comfort on trains and at station (train crowding during peak hours, air cond., level of noise, cleanliness).					
4. Better integration of rail transit system.					
5. Waiting time in station for rail transit.					
6. In-vehicle time of rail transit.					
7. Ticket fare of rail transit.					
8. Park and ride facilities at rail station					
9. Good access to rail transit station					

There were six variables involve in measuring to measure the perceived importance system of rail transit system to frequent rail transit users. The variables were also designed based on several literatures (Fillone, 2005;Wibowo, 2007).The variables in perceived importance quality was graded using 5- Likert scale, namely, 1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree* and 5 = *Strongly agree*. More discussion perceived service quality is explained in Section 3.14.3. Finally, the survey instrument for Part 3, Part 4a, Part 4b and Part 4c will be explained together with the analysis method in section 3.13 and 3.16.

3.5.2 Stated Preference (SP) Survey Questions

As mentioned previously, the survey instruments were designed using revealed preference (RP) and stated preference (SP) methods. The stated preference (SP) questions were designed to assess how frequent rail users will react to hypothetical scenarios and make choices between the given alternatives in much the same way as they might do when making choices in real situation (Chen et al. 2011). It involved the simulation of choice situations (Walker et.al, 2002). Despite some drawbacks, SP approach is used in order to assess how frequent rail transit users will react to different hypothetical scenarios and make choices between them in much the same way as they might do when making choices in real situation. In this study, the SP questions were designed to obtain information on travel mode choices preference among frequent rail transit users and private transport users over a series of hypothetical rail transit travel and accessibility scenarios. The SP approach used was choice experiment method (Cho and Kim 2007; Chen et al. 2011). However, the choice experiment method which was applied in this study has been modified and is slightly different from the current practice because each increment level of rail travel and access attributes scenarios, namely access cost, access time, access distance and etc. was answered individually and sequentially. The stated preference survey question for frequent rail users was included in Part 2b of the questionnaire, whereas the stated preference survey questions for private transport users was included in Part 3 of the questionnaire. The detail of each hypothetical scenario increment levels which were designed for frequent rail users and private transport users was presented in Table 3.10 and Table 3.11 below.

Table 3.10: Stated Preference (SP) Questions for Frequent Rail Users

Scenario and Level	Choice Preference			
Scenario 1: If access cost to rail transit station is increased to,	***I will travel using,***			
10% of your current access cost.		Rail		Private Transport
20% of your current access cost.		Rail		Private Transport
30% of your current access cost.		Rail		Private Transport
40% of your current access cost.		Rail		Private Transport
50% of your current access cost.		Rail		Private Transport
60% of your current access cost.		Rail		Private Transport
Scenario 2: If access time from home to rail transit station is increased to,	***I will travel using,***			
5 minutes of your current access time.		Rail		Private Transport
10 minutes of your current access time.		Rail		Private Transport
20 minutes of your current access time.		Rail		Private Transport
30 minutes of your current access time.		Rail		Private Transport
40 minutes of your current access time.		Rail		Private Transport
Scenario 3: If current access distance to rail transit station is increased to,	***I will travel using,***			
100m from your current access distance.		Rail		Private Transport
300m from your current access distance.		Rail		Private Transport
500m from your current access distance.		Rail		Private Transport
700m from your current access distance.		Rail		Private Transport
900m from your current access distance.		Rail		Private Transport
1000m from your current access distance.		Rail		Private Transport
Scenario 4: If overall travel cost to rail transit station is increased to,	***I will travel using,***			
10% of your current travel cost.		Rail		Private Transport
20% of your current travel cost.		Rail		Private Transport
30% of your current travel cost.		Rail		Private Transport
40% of your current travel cost.		Rail		Private Transport
50% of your current travel cost.		Rail		Private Transport
60% of your current travel cost.		Rail		Private Transport
Scenario 5: If overall travel time to rail transit station is increased to,	***I will travel using,***			
5 minutes of your current travel time.		Rail		Private Transport
10 minutes of your current travel time.		Rail		Private Transport
20 minutes of your current travel time.		Rail		Private Transport
30 minutes of your current travel time.		Rail		Private Transport
40 minutes of your current travel time.		Rail		Private Transport
Scenario 6: Assuming that current frequency of rail transit are 8 times per hour. If the frequency of rail transit arriving at the station is decreased to,	***I will travel using,***			
7 times per day.		Rail		Private Transport
6 times per day.		Rail		Private Transport
5 times per day.		Rail		Private Transport
4 times per day.		Rail		Private Transport
3 times per day.		Rail		Private Transport

Table 3.11: Stated Preference (SP) Questions for Private Transport Users

Scenario and Level	Choice Preference			
Scenario 1: Assuming that current fuel price is set to RM 2.05/litre. If the fuel price is increased to,	***I will travel using,***			
10% (RM 2.30)		Rail		Private Transport
20% (RM 2.50)		Rail		Private Transport
30% (RM 2.70)		Rail		Private Transport
40% (RM 2.90)		Rail		Private Transport
50% (RM 3.10)		Rail		Private Transport
60% (RM 3.30)		Rail		Private Transport
Scenario 2: If access cost to rail transit is decreased to,	***I will travel using,***			
10% of your current access cost.		Rail		Private Transport
20% of your current access cost.		Rail		Private Transport
30% of your current access cost.		Rail		Private Transport
40% of your current access cost.		Rail		Private Transport
50% of your current access cost.		Rail		Private Transport
60% of your current access cost.		Rail		Private Transport
Scenario 3: If access time from home to rail transit station is decreased to,	***I will travel using,***			
5 minutes of your current access time.		Rail		Private Transport
10 minutes of your current access time.		Rail		Private Transport
20 minutes of your current access time.		Rail		Private Transport
30 minutes of your current access time.		Rail		Private Transport
40 minutes of your current access time.		Rail		Private Transport
Scenario 4: If access distance from home to rail transit station is decreased to,	***I will travel using,***			
100m from your current access distance.		Rail		Private Transport
300m from your current access distance.		Rail		Private Transport
500m from your current access distance.		Rail		Private Transport
700m from your current access distance.		Rail		Private Transport
900m from your current access distance.		Rail		Private Transport
1000m from your current access distance.		Rail		Private Transport
Scenario 5: If travel cost per day using private transport is increased to,	***I will travel using,***			
10% of your current travel cost.		Rail		Private Transport
20% of your current travel cost.		Rail		Private Transport
30% of your current travel cost.		Rail		Private Transport
40% of your current travel cost.		Rail		Private Transport
50% of your current travel cost.		Rail		Private Transport
60% of your current travel cost.		Rail		Private Transport
Scenario 6: If travel time of using private transport is increased to,	***I will travel using,***			
5 minutes of your current travel time.		Rail		Private Transport
10 minutes of your current travel time.		Rail		Private Transport
20 minutes of your current travel time.		Rail		Private Transport
30 minutes of your current travel time.		Rail		Private Transport
40 minutes of your current travel time.		Rail		Private Transport

‘Table 3.11, continued’

Scenario and Level	**Choice Preference**			
Scenario 7: Assuming that current frequency of rail transit are 6 times per hour. If the frequency of rail transit arriving at the station is increased to,	***I will travel using,***			
7 times per day.		Rail		Private Transport
8 times per day.		Rail		Private Transport
9 times per day.		Rail		Private Transport
10 times per day.		Rail		Private Transport
11 times per day.		Rail		Private Transport
12 times per day.		Rail		Private Transport

Based on stated preference scenarios questions listed in Table 3.10, the frequent rail users were asked about their possibility to shift to private transport under different hypothetical stated preference scenarios levels. It was found that the frequent rail users who were selected as respondents were the ones that have vehicle as alternative travel mode, either by using their own vehicle or their household vehicle if their travel characteristics are about the change. Nevertheless, stated preference scenarios questions listed in the Table 3.11, the private transport users were asked about their possibility to shift to rail transit under different hypothetical stated preference scenarios levels. As mentioned previously, the private transport users who were selected as respondents have had previous experiences travelling by rail transit for their journey.

The stated preference scenarios levels were revised several times based on pre-test session and pilot study finding. This SP questionnaire design was proposed in this study with an aim to alleviate measurement error and cognitive difficulties of the respondents during on-field survey (Weisberg 2005; Biemer 2011). In addition, improvement on respondent’s disengagement and possibility to obtain irrational answers (IAs) in the survey will be reduced or preventable in order to attain more meaningful findings and adhere to research objectives (Weber &Johnson 2006; Petrik et al., 2016). Furthermore, current researches have revealed that with numerous variables, sets of attributes and levels which demand more cognitive efforts will lead to survey fatigue (Caussade et al., 2005; Hess et al., 2012; Petrik et al., 2016). Due to survey fatigue, respondents may answer the questions arbitrary which will reflect inconsistencies in their responses (Caussade et al., 2005; Hess et al., 2012; Petrik et al., 2016). For instance, frequent rail transit users will consider shifting to private transport if access cost is increased to 10% and 20% of their current access cost, but continue using rail transit if access cost is increased sequentially to from 30% until 60% of their current access cost.

In this study, there were six hypothetical scenarios designed for frequent rail users and seven hypothetical scenarios designed for private transport users. The hypothetical scenarios for frequent rail users were access cost increment, access time increment, access distance increment, travel cost increment, travel time increment, travel distance increment and decrement of rail frequency levels. While, the hypothetical scenarios for private transport users were access cost decrement, access time decrement, access distance decrement, travel cost decrement, travel time decrement, travel distance decrement, fuel price increment and increment of rail frequency levels. In the survey questions, the respondents (*frequent rail users* and private transport users) were asked for their response whether they would shift to *private transport*/rail transit or travel consistently with *rail transit*/private transport if their current travel and access attributes increases or decreases under various hypothetical situations.

3.6 Sampling Technique

The primary reason of sampling in quantitative studies is to create a representative sample that closely reproduces or represents features of interest in a larger cases collection, called the population (Neuman, 2011). In other words, if the samples were examined in detail and correctly sampled, the results can be generalized to the entire population. The sample plays an important role in making interpretation of a whole population through statistical analysis. This is because each observation will measure one or more attributes of the sample, for instance, age, gender, income and etc.

The sampling methods were categorized into two main methods of sampling, namely (i) probability sampling (also known as a random sample) and (ii) non-probability sampling (also known as a purposive sample) (Cohen & Holliday, 1996). In probability sampling, the chances of members of the wider population being selected for the sample are known, whereas in a non-probability sampling, the chances of members of the wider population being selected for the sample are unknown (Cohen et al., 2000). In other words, for probability sampling, every member of the population has an equal chance of being included in the sample. In non-probability sampling, some members of the wider population definitely will be excluded and others definitely included, which means every member of the wider population does not have an equal chance of being included in the sample (Cohen et al., 2000). In this study, the researcher used probability sampling method. This is because a probability sampling will have less risk of bias than a non-probability sample and can be highly accurate as compared to non-probability sample. In addition, it is possible to calculate "sampling error" in which a sample might be fluctuated from the population. The sampling error is the deviation between what is in the sample data and an ideal population parameter due to random processes (Neuman, 2011). In literature, there are several types of probability sampling methods, which are (i) simple random samples, (ii) systematic samples, (iii) stratified samples, (iv) cluster samples, (v) stage samples and (vi) multi-phase samples (Cohen et al., 2000; Neuman, 2011). Each of the probability sampling method has a measure of randomness built into them and therefore has a degree of generalizability (Cohen et al., 2000). In this study, the researcher used the random sampling method for sampling of respondents in the study area, i.e.

Klang Valley (KV). In this method, each sample is randomly selected by chance, so that each sample has the same probability of being chosen during the sampling process (Chuen, 2013).

3.7 Sampling Size

According to Cohen et al., (2000), when random sampling is used in the study, it was important to ensure that the sample size needed reflects the population value of a particular variable depends on the population size and heterogeneity. The most important element to be considered is that the sample drawn from the population must be representative so that it allows the researcher to make inferences or generalisation from the sample statistics to the studied population (Maleske, 1995; Chua, 2006). In other words, if the sample size is too low, it lacks precision to provide reliable answers to research questions investigated and if the sample size is too large, time and resources could be wasted often for minimal gain (Chua, 2006). The study by Salant and Dilman (1994) highlighted the four factors in sample size determination. Those factors were (i) how much sampling error can be tolerated, (ii) population size, (iii) how varied the population is with respect to the characteristics of interest and (iv) the smallest subgroup within the sample for which estimates are needed (Salant & Dilman, 1994; Chua, 2006). The size of probability random sample can be decided in two ways, namely, (i), the researcher exercising prudence and ensuring that the sample represents the wider features of the population with the minimum number of cases and (ii) by using a table which, from a mathematical formula which indicates the appropriate size of a random sample for a given number of the wider population (Cohen et al., 2000). Therefore, in this study, estimation of sample size in research using commonly employed method by Krejcie and Morgan, (1970) is applied.

The determination of sample size by Krejcie and Morgan, (1970) method was calculated using hereafter formula:

$$s = X^2 NP(1-P) \div d^2(N-1) + X^2P(1-P)$$

Where,

s = required sample size

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level

N = the population size

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (0.05)

However, to simplify the process of calculating the sample size, Krejcie and Morgan, (1970) produced a table for determining sample size from a finite population as tabulated in Table 3.12.

Table 3.12: Determining the Size of a Random Sample (Krejcie & Morgan, 1970)

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354

95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

N= Population size S= Sample size

It was indicated that in Krejcie and Morgan, (1970) table, the smaller the number of cases are in the wider, whole population, the larger the proportion of that population must appear in the sample. On the contrary, the larger the numbers of cases are in the wider, whole population, the smaller the proportion of that population will be in the sample. In relation to this study, as a rough guide in a random sample, the larger the sample, the greater is its chance of being representative. The relationship between sample size and total population is illustrated in Figure 3.6.

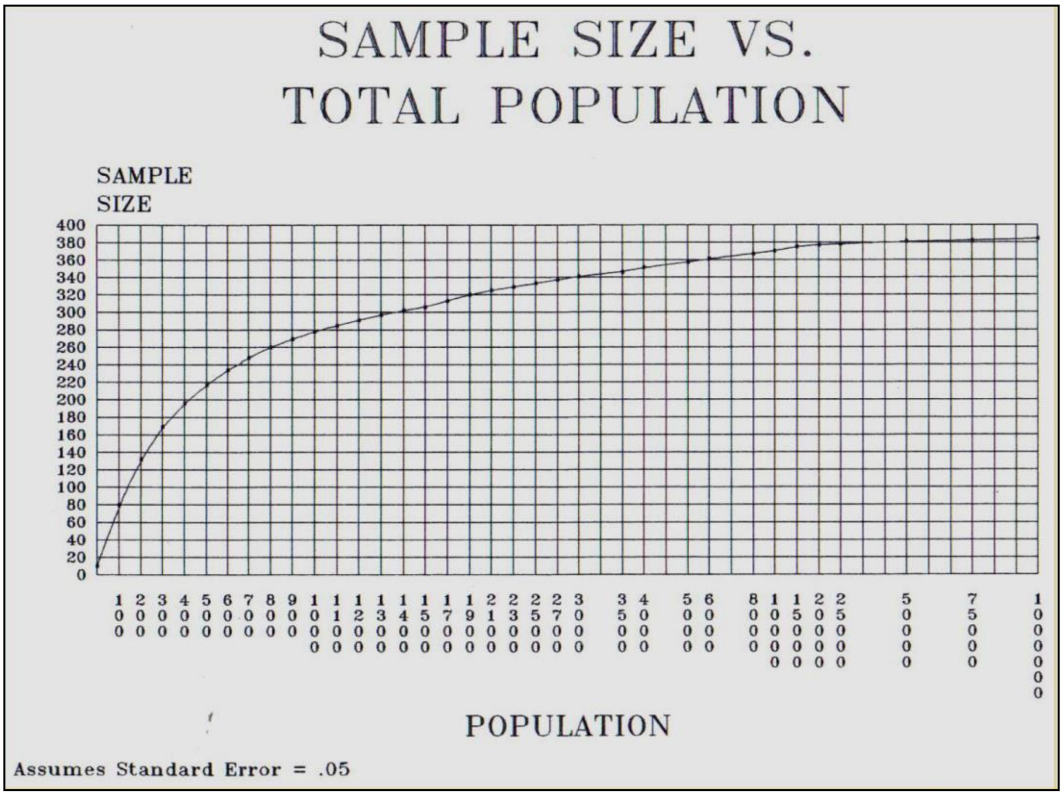

Figure 3.6: The Relationship between Sample Size and Population

(Krejcie & Morgan, 1970)

The research by Krejcie and Morgan (1970) found that as the population increases, the sample size increases at a diminishing rate and remains constant at slightly more than 380 cases. As a result, with confidence interval of 95% and population of 6.187 million capita (> 1 million) in the Klang Valley region (Department of Statistics Malaysia, 2011), the minimum sample size required for this study is 384.

3.8 Pilot Study

Before full scale study was conducted, a pilot study on the survey instruments was carried out to ensure that the questionnaire was acceptable and easy to answer by a wide background range of respondents in KV area. In this study, a sample size of 50 was collected and used in preliminary analysis of the study hypothesis. The sample size was essentially intended to be a fairly exploratory research exercise in order to establish general viability of the survey instruments in the questionnaire. The preliminary analysis from pilot study leads to testing more precise hypotheses in the full scale study. In addition, the researcher is able to thoroughly check of planned statistical analysis and analytical procedures in order to evaluate usefulness and efficiency of the collected data.

Based on the pilot study findings and respondents feedback, several adjustments are needed on the survey instruments in the questionnaire to fulfil the purpose of this study. A question on Part 1b: Daily Travel Itinerary, which asked about the respondents usual trips from their home to their final destination, was revised. The respondents were asked to fill up and arrange their daily itinerary in simple diary table. However, the respondents found difficulties to understand the meaning of the questions and gave inappropriate answers on their daily trips. The newly adjusted question on daily travel information was arranged into the ordinal scale choices. To name a few, access time, access cost and access distance questions were arranged in ordinal scale measurement by increasing those values in range. Another related travel information question was added in the survey to determine the origin of the trip and the targeted location, which were (i) “Where are you coming from (area)?” and (ii) Where is you final destination (area)?” Another amendment was the question on the respondents’ trip purposes. Previously, only two trip purposes were listed in the choice, namely, (i) education and (ii) workplace/office. Another trip purpose, namely, (iii) shopping/social/recreation was added in the question to differentiate between trips. In addition, the new question was asked in order to determine an alternative mode of transport. The question was asked to both types of respondents, which were listed in their own section. The question was “If your main travel mode was a rail transit, please state your next preferred mode (if any)” and “If your main travel mode was a private vehicle, please state your next preferred mode (if any)”. Additionally, revisions on Likert response scale questions for frequent rail users were also carried out.

Those amendments involved rephrasing the statements on perceived service quality of rail transit and rephrasing the statements on importance-performance level measurement for each access mode indicators. The frequent rail users were having difficulties to understand the long statements in each Likert response scale questions during pilot study. Finally, questions on hypothetical stated preference scenarios for frequent rail users and private transport users were also revised.

3.9 Data Collection Method

The selection of data collection method is influenced by several factors, namely, choice method's cost, the coverage size of the method on the target population, the method flexibility during data collection, willingness of the respondents in the selected method and the responses accuracy when using the method (Neuman, 2011).

As mentioned previously, the target groups in this study are (i) commuters who frequently using urban rail transit system in Klang Valley for work, study and other purposes for at least eight times per week (including the return trip) using rail transit and (ii) commuters who are travelling by private transport in KV for work, study and other purposes. In this study, the primary data was collected through on-field survey. The data was collected in various rail station areas to obtain actual access mode of the frequent rail users. In addition, some of the survey was done at the shopping malls near rail station services. The important characteristic that needs to be considered is the vehicle availability among frequent rail transit users. In this study, the vehicle availability referred to either the frequent rail transit users has their own vehicle or if not, whether their households have available vehicle as daily travel mode. This factor was importantly put into considerations because the frequent rail transit users was also asked about the probability of shifting to private transport mode if the current rail travel attributes, namely, access cost, access time, access distance etc. are about to increase in the future. The frequent rail users took between 10-15 minutes to complete the survey. For private transport users, on-field survey was carried out in the offices, workplaces such as universities, government agency, private sectors and related places which were located near rail transit station in KV area. Interestingly, there were some cases of private transport users who did not travelling by rail transit mode although their residential area are within the rail transit catchment area. In addition, the private transport users who answered the questionnaire should also have experiences travelling by rail transit in KV. This was because there were questions on rail transit services which involved their views and preferences to consider shifting to rail transit mode if their current travel attributes, namely, travel cost, fuel price and etc. are about to increase. The private transport users took between 10-15 minutes to complete the survey. In this study, all the data was collected solely by the researcher. All the data was collected in 4 months period. During data collection process, there is no personal information, namely, respondent's name, email addresses or home addresses were recorded. The survey was carried out at random. The respondents were recruited on a voluntary basis and can stop participating at any given moment. The respondents were asked by the enumerator, whether they would like to participate in the survey, and when they verbally agreed, this was taken to imply consent. In addition, it was not feasible to attain written consent due to the survey environment. In this study, the enumerator will ask the questions and the respondent's answers was recorded, which ensuring higher quality data and responses rate. According to Chua (2013), the on-field survey is recommended when desired sample involves of respondents in a very specific target population. This method is considered as an appropriate research method for this study because the respondents are highly knowledgeable individuals whose experience is required for the understanding of the rail transit system and private transport issue.

Throughout this study, 583 survey responses were collected. However, after screening process, 14 incomplete responses were discarded. The acceptance rate for the survey responses was 97.6%. The survey replied from frequent rail users were 335 and the responses from private transport users were 245. The sample size was fulfilled the minimum of 384 responses to achieve 95% confidence level and 5% margin of error for population sizes of 100 million and below (Krejcie & Morgan, 1970).

3.10 Data Processing and Mode of Data Analysis

In this study, the collected data from questionnaire survey was analysed using two types of statistical techniques softwares, namely Statistical Package for Social Science (SPSS) version 21 and Structural Equation Modelling analysis using AMOS (Analysis of Moment Structure) version 21.

The data processing was started by "defining the variables". In this step, the required information for each variable was specifying in the Variable View tab. Then, the data entry process was carried out. After that, the data were screened and cleaned by checking whether the data had the appropriate frequency through descriptive statistics analysis, as well as coding and data entry. The data were also cleaned for inconsistencies, errors, missing values and outliers. The validity, reliability and normality tests were carried out to verify the cleaned data, to examine the data consistencies and to examine the data distribution. In addition, the normality test was also important in deciding the right statistical tests to analyse the data.

The summary of analysis method with respect to research objectives is tabulated in Table 3.13.

Table 3.13: The Summary of Analysis Method

Research Objective	Analysis Methods
RO1: To identify and discuss the access trip pattern to rail transit station as well as travel behavior of frequent rail transit users and private transport users in Klang Valley, Malaysia.	Descriptive Statistics, Pearson Correlation
RO2: To investigate the influence of access and travel characteristics scenarios as well as socio-demographic factors on the willingness of frequent rail transit users to travel consistently by rail and the potential of frequent rail transit users shifting to private transport.	Binomial Logistic Regression Modelling
RO3: To investigate the influence of access and travel characteristics scenarios and socio-demographic factors on the willingness of private transport users to travel consistently using private vehicle and the potential of private transport users shifting to rail transit.	Binomial Logistic Regression Modelling
RO4: To identify and investigate the current access modes indicators that are priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance and importance level.	Importance-Performance Analysis (IPA)
RO5: To improve the walking surface for pedestrian accessing the rail transit station.	Laboratory Investigation
RO6: To evaluate the rail transit system traits that is of importance and priority to frequent rail users.	Structural Equation Modelling (SEM) Approach
RO7: To develop the structural equation model for perceived importance of rail transit system.	Structural Equation Modelling (SEM) Approach

3.10.1 The Reliability Analysis

Reliability analysis is used to determine the extent to which the items in the questionnaire were related to each other in order to provide an overall index of repeatability or internal consistency of the scale as a whole, and to identify the problematic items that should be excluded from the scale. The reliability procedure calculates a number of commonly used measures of scale reliability and also provides information on the relationships between the individual items in the scale. Cronbach's (1970) alpha was computed to assess the model for internal consistency, based on the average inter-item correlation used to determine the homogeneity of its items. The Cronbach alpha estimates the proportion of variance that is systematic or consistent in a set of test scores. It can range from 00.0 (if no variance is consistent) to 1.00 (if all the variance is consistent), with all values in-between being possible. A Cronbach alpha of < 0.5 implies low correlation.

3.10.2 Discrete Choice Modelling

The discrete choice model is a mathematical function which is used to analyse and predict a decision maker's choice based on utility or relative attractiveness (McFadden, 1974; Ben-Akiva & Lerman, 1985; Koppelman & Bhat, 2006). The discrete choice model is represented by a theoretical framework in terms of the utilitarianism. Utilitarianism is a theory which describes how an action taken is decided by other influences, for instance, satisfaction, pleasure or the importance of preferences to overall utility (Chuen, 2013). In discrete choice models, the probability of choosing or shifting to particular alternatives is proportional to the difference between its estimated utility and the estimated utility of other available alternatives (Bergman et al., 2011). The utility function, U, has the property that an alternative is chosen if its utility is greater than the utility of all other alternatives in the individual's choice set (Ben-Akiva & Lerman, 1985). The interactions of each attribute (V) in the utility function of a mode are presented by its coefficients (b) and are estimated using maximum likelihood methods (McFadden, 1981). The utility function for transport mode *(x)* is the sum of a set of weighted *(b)* attributes of choice *(V)*, such as:

$$U_x = b_1 V_{1x} + b_2 V_{2x} + b_3 V_{3x} + \cdots + b_i V_{ix} + e_{x,} \quad (1)$$

Where:

U_x = the utility function of travel by transport mode x

V_{1x} = travel time with transport mode x

V_{2x} = travel cost with transport mode x

V_{3x} = travel distance with transport mode x

b_1, b_2, b_3, b_4 = weight of each attribute

e_x = the mode constant

The most common form of mode choice model is the logit model. It was found that the logit model has been found to fit the mode choice making behaviour quite well (Kamba, 2007). There were three main techniques of logit models, namely, (i) binomial logit models, (ii) multinomial logit models and (iii) nested logit models (McFadden & Train, 2000). The difference of each model can be explained or demonstrated by a scenario, whereas; there are three choices of travel modes, namely, car, rail and bus. For multinomial logit model, the commuter will look at the three travel mode choices and select one of the mode. In nested logit model, the commuter will firstly decide whether to select private transport or public transport as their preference travel mode and if the commuter chooses public transport, the second decision is whether to consider using bus or train. However, the decision-making between train and bus is not even considered if a private transport was chosen in the model. In contrast, the multinomial logit model with only two alternatives is called binomial logit model. The logit models were employed for regression analysis because of their ability to represent complex aspects of travel decisions made by individuals incorporating important demographic and policy-sensitive explanatory variables (Kamba, 2007). The logit models do not assume linearity in the relationships between the independent and dependent variables and the variables were not required to be normally distributed. In the logit model, the utility function of mode x is a log ratio of the probability of choosing mode x to the probability of not choosing mode x (McFadden, 1974);

$$\log \frac{P_x}{1 - P_x} = U_x$$

Where P_x = Probability of choosing transport mode x

The utility function of mode x can also be expressed as;

$$\log \frac{P_x}{1 - P_x} = b_1 V_{1x} + b_2 V_{2x} + b_3 V_{3x} + \cdots + b_i V_{ix} + e_{x,}$$

Through algebra, the model can be interpreted into;

$$P_x = \frac{e^{U_x}}{1 + e^{U_x}}$$

In this study, binomial logit model will be developed. For frequent rail transit users, the models were developed based on research hypothesis in Table 3.1. The following binary logit models were developed;

Model 1: For influence of socio-demographic characteristics and access cost increment on shifting probability to private transport.

Model 2: For influence of socio-demographic characteristics and access time increment on shifting probability to private transport.

Model 3: For influence of socio-demographic characteristics and access distance increment on shifting probability to private transport.

Model 4: For influence of socio-demographic characteristics and travel cost increment on shifting probability to private transport.

Model 5: For influence of socio-demographic characteristics and travel time increment on shifting probability to private transport.

Model 6: For influence of socio-demographic characteristics and rail frequency decrement on shifting probability to private transport.

For private transport users, the models were developed based on research hypothesis in Table 3.1. The following binary logit models were developed;

Model 1: For influence of socio-demographic characteristics and fuel price increment on shifting probability to rail transit.

Model 2: For influence of socio-demographic characteristics and travel cost increment on shifting probability to rail transit.

Model 3: For influence of socio-demographic characteristics and travel time increment on shifting probability to rail transit.

Model 4: For influence of socio-demographic characteristics and access cost decrement on shifting probability to rail transit.

Model 5: For influence of socio-demographic characteristics and access time decrement on shifting probability to rail transit.

Model 6: For influence of socio-demographic characteristics and access distance decrement on shifting probability to rail transit.

Model 7: For influence of socio-demographic characteristics and rail frequency increment on shifting probability to rail transit.

In frequent rail transit users cases, the utility of rail transit was used as reference category. The dependent variable was coded 0 if the frequent rail transit users travel consistently by rail or 1 if the frequent rail transit users shift to private transport. In private transport users cases, the utility of private transport was used as reference category. The dependent variable was coded 0 if the private transport users travel consistently by private transport or 1 if the private transport users shift to rail transit. The explanatory variables were; gender, age, monthly income, educational stress, travel purpose, job status, number of vehicle per household, availability of driving license, number of trips and increment of travel characteristics under different hypothetical scenarios. The independent variables which included in the models were based on several literatures (Fillone et al., 2005; Wibowo, 2007; Kamba, 2007, Chuen, 2013) and depended on how detailed were the trip data available and also the significance of the variables in explaining the mode choice behaviour. Summaries of the explanatory variables (independent variables) in the models and their coding systems are presented previously in Tables 3.2- 3.3. In order to determine the influence of these factors on mode switching behaviour, each factor was tested separately.

3.11 Evaluating the Overall Performance of the Binomial Logit Models

A Forced Entry Method in SPSS was used in this study. In this approach, all predictor variables are tested in one block to assess their predictive ability, while controlling for the effects of other predictors in the model (Pallant, 2007). For binomial logit models analysis, several statistics can be used to compare alternative models or evaluate the performance of a single model. The interpretation on statistics or output from analysis as follows;

(i) Maximum likelihood Estimation (MLE)

Specifically, the parameter values are estimated using Maximum Likelihood Estimation (MLE) (Field, 2011). The Maximum Likelihood Estimation (MLE) seeks to maximize the log likelihood, (LL)2, which reflects how likely it is for the dependent variable to be predicted by the independent variables (Rao, 1973; Kamba, 2007). In SPSS, the log-likelihood was reporting by multiplying the value of log-likelihood by -2, which referred to as -2LL (Field, 2011). Since -2LL has an approximately chi-square distribution with degrees of freedom equal to the number of predictors, it is used to assess the significance of the logistic regression model. It was required that the value of -2LL should be less than the value when only the constant was included in the model. This was because lower values of -2LL indicate that the model is predicting the outcome variable more accurately (Field, 2011).

(ii) Classification Table

A classification table was used to evaluate the predictive accuracy of the logistic regression model. In the table, the observed values for the dependent outcome and predicted values (at a cut-off value of p=0.50) are cross-classified (Kamba, 2007). The classification table provide an indication of how well the model is able in predicting the correct category for each case (Pallant, 2007).

(iii) Effect Size

The SPSS generates three different pseudo-R^2 summary statistics, which was used to assess model fit by determining the effect size of the model. The three pseudo-R^2 statistics were McFadden, Cox and Snell and Nagelkerke. McFadden's-R^2 statistic (sometimes called the likelihood ratio index [LRI]) (McFadden, 1974) is transformation of the likelihood ratio statistic. Values from 0.2 to 0.4 for the McFadden are considered “highly satisfactory” (Hensher & Johnson, 1981; Tabatchnick & Fidell, 2007). The Cox and Snell measure indicates a better model fit for higher R^2. However, this measure is limited in that it cannot reach the maximum value of 1. Nagelkerke pseudo-R^2 (Nagelkerke, 1991) proposed a modification that allows a value of 1. In this study, the three pseudo-R^2 measurement was used and compared to indicate the strengths of the relationships.

(iv) Identifying Statistically Significant Predictor Variables

The **Variables in the Equation** table gives information about the contribution or importance of each predictor variables. The columns in the table, which reported in this study, were labelled **Wald, Sig., B** values and the **Exp (B)**. The variables which contribute significantly to the predictive ability of the model were determined in **Sig.**column (values less than 0.05). The **B** values from significant variables were used to calculate the probability of a case falling into a specific category (Pallant, 2007). An interpretation of the logit coefficient which is usually more intuitive (especially for the dummy independent variables) is the "odds ratio”, **Exp(B)**. The odds ratios less than 1 indicate a lower likelihood for the event of interest; odds ratios greater than 1 indicate greater likelihood for the event of interest. In other words, the odds ratio is the probability of an event happening divided by the probability of it not happening (Petrucci, 2009).

3.12 The Application of Structural Equation Modelling (SEM) Approach

The Structural Equation Modelling (SEM) approach was used in questions Part 1b: Rail Users’ Travel Experience, Part 4a: Rail Transit Users’ Satisfaction, Part 4b:Perceived

Service Quality of Rail Transit System and Part 4c: Perceived Importance of Rail Transit System.

In this study, the proposed Structural Equation Modelling (SEM) with latent variables are developed using the IBM SPSS Amos Software version 21. AMOS is abbreviation for Analysis of Moment Structures and AMOS is the latest software, which was developed for SEM analysis. Through the employment of AMOS Graphic, the inter-relationship among latent constructs can be modelled and analysed effectively and accurately (Zainudin Awang, 2015). The AMOS software has the most user-friendly graphical interface as compared to other SEM software, to name a few; LISREL, EQS and Mplus (Cunningham & Wang, 2005). The AMOS software does not require any syntax or complicated programming language to run the software. In AMOS, the SEM paradigm is developed by connecting the latent variables (circles) and manifest variables (boxes) via arrows. Besides, the multiple equations of inter-relationships in a model are computed simultaneously. However, AMOS has some disadvantages. In AMOS software, the drawing or creation of many images would be a very tedious work if the model is complex. For instance, in LISREL software, the complex model development can be done simply with programming language by copying and duplicating the syntax. In addition, the AMOS software has a limited capacity to work with categorical response variables, namely logistic or probit forms and also has a limited capacity for multi-level modeling as compared to Mplus software.

In this SEM analysis section, the first objective is to investigate the influence of rail users' travel experience, perceived service quality, and rail users' satisfaction on the perceived importance of rail transit system. By using the structural equation modelling approach, the possible mediator effect in the (1) rail users' travel experience-perceived service quality-rail users' satisfaction paradigm, (2) rail users' travel experience-perceived importance-rail users' satisfaction paradigm and (3) perceived service quality-rail users' satisfaction-perceived importance paradigm were considered. As the proposed model in this study was new, several limitations and constraints were anticipated and stated. This will lead to the second objective, which is to evaluate the rail transit system traits that are of importance and priority to frequent rail users. Consequently, this study considers all those hypothesised constructs to be analysed simultaneously, using Structural Equation Modelling, and hence, propose an integrated model of important rail transit system traits in Klang Valley. The proposed structural model and measurement models will be explained in the following sub-sections.

3.12.1 Proposed Structural Model and Measurement Models

In this study, the proposed structural model is unique because it considers new exogenous variables, which previously are untested relationship. The proposed structural model in regards to perceived importance of rail transit system traits is new and there are no related studies, which mainly focused on the possible relationship between the latent constructs. The previous related study was a structural model of public transport user which was developed by Fillone et al., (2005) using LISREL software. In Fillone et al., (2005) study, it was discovered that the socio-demographic status construct and urban travel experience construct was significantly influenced the assessment of public transport traits. However, throughout this study, the proposed structural model for perceived importance of rail transit system traits was carried out by considering other exogenous variables which will influence the perceived importance of the rail transit system traits. In this study, the perceived importance was predicted (assumed) to be influenced by the frequent rail users' travel experience (characteristics), perceived service quality of rail transit system and rail users' satisfaction. The additional exogenous variables are perceived service quality and rail user satisfaction. A number of studies have investigated the relationship between service quality and users satisfaction on transportation service sectors (Tam et al., 2005; Changa & Chen, 2007; Chenga et al., 2008; Githui et al., 2010; Yu & Lee, 2011;Eboli & Mazulla, 2012; Borhan, et al., 2014). Hence, it is feasible to examine the relationship of service quality and customer satisfaction that may exist on the perceived importance of the rail transit system.

The proposed measurement models that are used to determine the indicators for the latent variables are also depicted. Perceived importance, rail users' travel experience, rail users' satisfaction, and perceived quality are considered as latent variables with multiple indicator measures. The proposed structural model to evaluate the perceived importance of the rail transit system is shown in Figure 3.7.

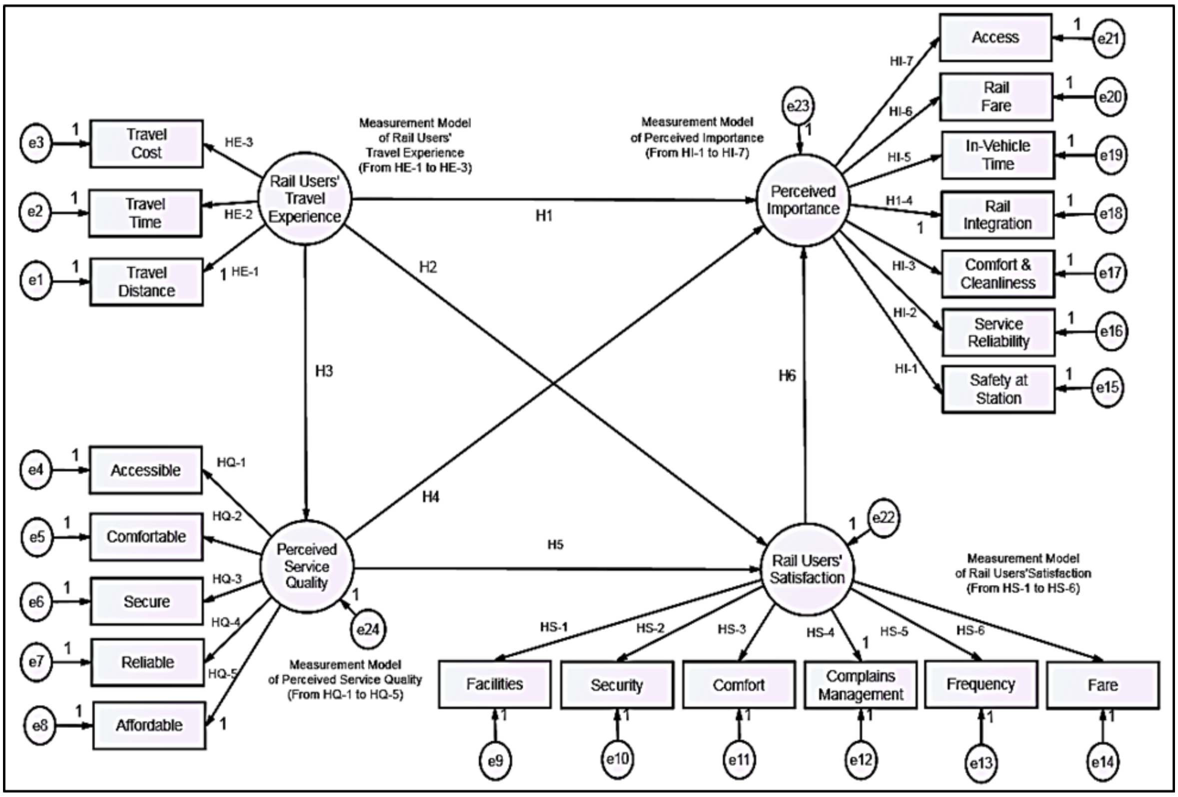

Figure 3.7: Proposed Structural Model for Perceived Importance of Rail Transit System

As depicted in Figure 3.7, there were four latent constructs in the hypothesized or proposed model. The latent constructs were (1) rail users' travel experience which consisted of three indicators (HE-1 to HE-3), (2) perceived service quality which consisted of five indicators (HQ-1 to HQ-5), (3) rail users' satisfaction (HS-1 to HS-6) which consisted of six indicators and perceived importance of rail transit system traits consisted of seven indicators (HI-1 to HI-7). There were six causal relationships which were indicated by one-headed line, namely H1 until H6. In the proposed model, e1 until e21 are errors of measurement and e22 until e24 are equation errors. In the model, the error is described as a residual which represents or shows an unexplained part by the indicators or variables (Zainudin Awang, 2015). The explanation on structural model and each latent construct is presented in sub section 3.12.2 and section 3.13.

3.12.2 The Perceived Importance Structural Model

A structural model is a model that demonstrates the correlational or causal dependencies among the measurement models (Zainudin Awang, 2015). In this study, the structural model for the perceived importance of the rail transit system was measured as a latent variable since it cannot be directly observed. The perceived importance of the rail transit system can be inferred by other related variables that are observable and directly measured. The perceived importance measurement model evaluates the significant or priority level of rail transit system traits or attributes among frequent rail transit users. A higher assessment level might indicate a higher influence of rail service traits in developing a prominent rail transit system. The study on the assessment level of rail service traits is statistically significant especially to transport planners and rail service operators. This is because by understanding the perceived importance of rail transit traits from frequent users' perspective, related influential issues and priority values that contribute to the quality of the rail transit system as an effective travel mode can be identified.

The structural model is hypothesised such that if the rail transit system has provided sufficient quality in their services (Perceived Service Quality), there is a higher tendency of frequent rail users to be highly satisfied with the system (Rail User Satisfaction) (H5). The perceived service quality of the urban rail transit system (Perceived Service Quality) is also predicted to positively influence the priority level of rail transit system traits. If frequent rail users perceive the rail transit system to be of higher service quality, there is a higher tendency of frequent rail users to highly comprehend which rail transit traits are of higher importance to them (H4). The causal relationship is hypothesised that frequent rail user satisfaction (Rail Users' Satisfaction) has a positive relationship with important or priority level of specific rail transit traits that influence their choice to travel with the rail transit mode (Perceived Importance) (H6).

Besides rail users' satisfaction and perceived service quality of the rail transit system, another causal relationship is that the perceived importance of the rail transit system is hypothesised to be influenced by rail users' travel experience (H1). It was proposed that frequent rail users who experienced longer travel distances, longer travel time, and higher travel cost will positively comprehend which rail transit traits are of higher importance to them when travelling by rail. In addition, rail users' travel experience is also hypothesised to influence rail users' satisfaction and perceived service quality (H2 and H3). It is assumed that if frequent rail users experienced longer travel distances, longer travel time, and higher travel cost, they will not perceive the service to be of higher quality and will not be satisfied with the rail transit system.

The latent variables do not only influence the perceived importance of the rail transit system, but may also have some influence between the indicators, and therefore, needs to be attained in Structural Equation Modelling. The following respective hypothesis statements are constructed for the latent variables:

H1: Rail users' travel experience has a significant causal effect on the perceived importance of rail transit system traits.

H2: Rail users' travel experience has a significant causal effect on rail users' satisfaction.

H3: Rail users' travel experience has a significant causal effect on the perceived service quality of rail transit system.

H4: Perceived service quality has a significant causal effect on the perceived importance of rail transit system traits.

H5: Perceived service quality has a significant causal effect on rail users' satisfaction.

H6: Rail users' satisfaction has a significant causal effect on the perceived importance of rail transit system traits.

The perceived importance of the rail transit system traits that have a higher influence on frequent rail users is measured using observed variables. Based on the model suggested by Fillone et al., (2005), there were four observed variables identified as observed variables in the assessment level construct. The indicators were order, safety and security, convenience and accessibility, and service reliability. Throughout this study, another four indicator variables of the assessment level construct (perceived importance) are identified. These six indicators were proposed based on Githui et al., (2010); Tippichai et al., (2010), and Khalid et al., (2014). The significant indicator variables are rail safety, service reliability, comfort and convenience, rail integration, in-vehicle time, rail fare, and access to rail station. For all items or indicators, the respondents were asked to indicate their preferences based on a five-point Likert-type scale (1 = Not at all important to 5 =Extremely important). For the observed variables, the assumptions (or hypotheses) are as follows:

HI-1: A frequent rail user with a higher comprehends level on rail transit system tends to believe that rail safety is a priority when travelling with the rail transit system.

HI-2: A frequent rail user with a higher comprehends level on rail transit system tends to believe that service reliability is a priority when travelling with the rail transit system.

HI-3: A frequent rail user with a higher comprehends level on rail transit system tends to believe that comfort is a priority when travelling with the rail transit system.

HI-4: A frequent rail user with a higher comprehends level on rail transit system tends to believe that integration between rail system is a priority when travel with the rail transit system.

HI-5: A frequent rail user with a higher comprehends level on rail transit system tends to believe that in-vehicle time is a priority when travel with rail transit system.

HI-6: A frequent rail user with a higher comprehends level on rail transit system tends to believe that rail fare is a priority when travel with rail transit system.

HI-7: A frequent rail user with a higher comprehends level on rail transit system tends to believe convenience and good access to rail station is a priority when travel with rail transit system.

The research hypotheses for other measurement models are explained in the following sub-sections.

3.13 The Measurement Models

In this study, the influence and relationship between the latent variables were carried out simultaneously. The model that demonstrates the relationship between response items and their underlying latent construct is termed as a measurement model (Zainudin Awang, 2015).

3.13.1 The Rail Users' Travel Experience Measurement Model

The rail users' travel experience measurement model refers to frequent rail users' daily trip data, which includes their travel distances, travel cost, and travel time from home to their final destination (including the return journey). The indicators proposed in the Rail Users' Travel Experience measurement model were slightly different from Fillone et al. (2005) study. Research by Fillone et al. (2005) included household type, ride time, total travel time and travel cost as indicators to represent their Urban Travel Experience measurement model. Whereas, in this study, the indicators to reflect Rail Users' Travel Experience measurement model were travel distance, travel time and travel cost. Throughout this study, the frequent rail users who travel longer distances, longer time, and spend higher travel cost might have an unfavourable travel experience as compared to those who travel shorter distances, shorter travel time, and spend lower travel cost. The following respective hypothesis statements are constructed for the rail users' travel experience measurement model:

HE-1: A frequent rail user who travels a longer trip distance tends to have unfavourable travel experience.

HE-2: A frequent rail user who travels a longer trip time tends to have unfavourable travel experience.

HE-3: A frequent rail user who spends higher trip cost tends to have unfavourable travel experience.

3.13.2 The Perceived Service Quality Measurement Model

The service quality is a customer's overall perception of the relative inferiority or superiority of the organization and its services (Bitner & Hubbert, 1994). In the context of this study, if frequent rail users perceived that the rail transit system is more effective, there is a higher propensity for them to believe that the current rail transit system has provided sufficient quality to fulfil their needs or requirements. The proposed indicators in service quality measurement are based on the perceptions of the frequent rail users. For all items, the respondents were asked to indicate their preference based on a five-point Likert-type scale (1 = Strongly disagree to 5 = Strongly disagree). The following respective hypothesis statements are constructed for the perceived service quality measurement model:

HQ-1: A frequent rail user who perceives the rail transit system to be of a higher quality will have a higher propensity to perceive that the rail system is accessible from home.

HQ-2: A frequent rail user who perceives the rail transit system to be of a higher quality will have a higher propensity to perceive that the rail system is comfort.

HQ-3: A frequent rail user who perceives the rail transit system to be of a higher quality will have a higher propensity to perceive that the rail system is secure.

HQ-4: A frequent rail user who perceives the rail transit system to be of a higher quality will have a higher propensity to perceive the rail system to be reliable.

HQ-5: A frequent rail user who perceives the rail transit system to be of a higher quality will have a higher propensity to perceive that travelling with rail transit is affordable.

3.13.3 The Rail Users' Satisfaction Measurement Model

In general, customer satisfaction is defined as a judgement made on the basis of a specific service encounter (Bolton & Drew, 1991; Cronin & Taylor, 1992; Park et al., 2006). The customer satisfaction is the ultimate goal in service operations of the companies or systems. As related to this study, the customer satisfaction was referred to the rail transit users' satisfaction. The measurement model evaluates frequent rail users' perception and judgment on rail transit service performance. The studies by Eboli and Mazzulla (2011) and Hayes (2008) stated the importance of customers' perception and expectation as an indicator to evaluate service quality and effectiveness. This is because the designated rail service should be customer-oriented and meet the customers' need requirements and desires (Schiefelbusch & Dienel, 2010; Noor & Foo, 2014). In this study, the respondents were asked to indicate their preference based on a five point Likert-type scale (1 = Very poor to 5 =Very good). The following respective hypothesis statements are constructed for the rail users' satisfaction measurement model:

HS-1: A frequent rail user with a higher satisfaction level has a higher tendency to believe that the rail services fulfil their needs in terms of facilities at the station and inside the rail transit.

HS-2: A frequent rail user who is highly satisfied with the rail service has a higher propensity to be satisfied with the safety condition at the station and inside the rail transit.

HS-3: A frequent rail user who is highly satisfied with the rail service has a higher propensity to be satisfied with comfortability at station and inside rail transit.

HS-4: A frequent rail user who is highly satisfied with the rail service has a higher propensity to be satisfied with the management of complaints by the service operator.

HS-5: A frequent rail user with a higher satisfaction level has a higher tendency to believe that the rail services fulfil their needs in terms of frequency.

HS-6: A frequent rail user with a higher satisfaction level has a higher tendency to believe that the rail services fulfil their needs in terms of fare.

The details on procedures or steps to develop the Structural Equation Modelling, models validation, model modification and model fitness will be explained in the following sections.

3.14 The Development of Structural Equation Modelling (SEM)

The Structural Equation Modelling (SEM) consists of two model components, namely (i) the measurement model, and (ii) the structural model. The measurement model defines and examines the relationship between observed variables and unobserved variables or latent variables (Bollen, 1989; Blunch, 2008; Byrne, 2010). In contrast, the structural model defines relationships among the unobserved variables (Byrne, 2010). The structural model utilises multiple regression paths among latent variables to assess specific relationships between constructs (Bollen, 1989; Blunch, 2008). In the SEM approach, multiple equations are solved simultaneously to identify the parameter estimates through a formal model specification (Khoo & Ghim, 2013). Then, SEM is examined for model fit through various goodness-of-fit tests. In SEM, both exogenous (independent) and endogenous (dependent) variables are considered. In addition, both exogenous and endogenous variables can be observed or latent. The basic equation of the structural model is shown as follows (Bollen, 1989);

Structural model equation, $\eta = \beta\eta + \Gamma\xi + \zeta$ (1)

Where, η (eta) is an (m x 1) vector of the endogenous or dependent latent variables; ξ *(xi)* is an (n x 1) vector of the exogenous or independent latent variables; ζ *(zeta)* is an (m x 1) random vector of residuals; β is a (m x m) coefficient matrix for latent endogenous variables and Γ is an (m x n) coefficient matrix for latent exogenous variables (Bollen, 1989).

As stated by the measurement models for endogenous or dependent variables and exogenous or independent variables, the basic equations are shown as follows (Bollen (1989);

Measurement model equation, $x = \Lambda_x \xi + \delta$ (2)

$y = \Lambda_y \eta + \varepsilon$ (3)

Where, *x* and δ are column q-vector related to the observed exogenous or independent variables and errors; Λ_x is the (q x n) coefficient matrix for the effects of the latent exogenous variables on the observed variables; *y* and ε are column p-vectors related to the observed endogenous or dependent variable and errors, and Λ_y is a *(p x m)* coefficient matrix for the effects of the latent endogenous or dependent variables on the observed ones (Bollen, 1989; Khoo & Ghim, 2013).

The data that was used in this study is a Likert scale items that realistically represent the categorical data of an ordinal scale. In this study, the development of the model using ordinal data was carried out as if the data was continuous. Although there has been an ongoing debate in the literature concerning the pros and cons of this practice, several references justified that with a large number of categories and when the data approximates a normal distribution, the analysis are considered feasible (Bollen, 1981; Johnson & Creech, 1983; Bentler & Chou, 1987; Atkinson, 1988). The data were cleaned, screened and examined for missing value and multivariate outliers before the data are ready for analysis (Tabachnik & Fidell, 2001). In SEM, the applied assumptions were similar as multivariate statistical methods. The data were examined for normality, multicollinearity and linearity before full structural model analysis can be carried out. For normality requirement, the data were examined for skewness and kurtosis values. According to Kline, (1998), the cut-off value for extreme skewness is 3 and kurtosis is 10 (Kline, 1998). The bivariate multicollinearity was examined by inspection of the correlation matrix for the association among the individual variables. If a correlation coefficient was 0.85 and above, the variable was considered as redundant (Kline, 1998; Tabachnick & Fidell, 2001).

In SEM, the validating procedure is called Confirmatory Factor Analysis (CFA). The CFA has the ability to assess the unidimensionality, validity, and reliability individually or in group (Zainudin Awang, 2015). However, the unidimensionality assessment should be made first prior to assessing the validity and reliability. In unidimensionality assessment, all measuring items were ensured to have acceptable factor loadings for the respective latent construct. In this study, the factor loading for every item should exceed 0.5 since the indicators used were newly proposed items (Zainudin Awang, 2015). The deletion of the measuring items or indicators was made one item at a time by deleting the lowest factor loading at first. The analysis on the new measurement model was carried out after the item was deleted. The process was continued until the unidimensionality requirement was achieved. Besides, the unidimensionality also require all the factor loadings to be in one direction either to be positive or negative.

Validity means the ability of instrument to measure what is intended to be measured (Zikmund, 2003). For validity assessment, content and construct validity (convergent and discriminant validity) have been examined. Each validity assessment is explained below;

(i) **Content validity** is the extent to which there is a need for the adequate coverage of all the domains of the constructs being examined (Cooper & Schindler, 2001). The content validity cannot be examined using statistical analysis and therefore, a comprehensive exploration of the literature and an extensive search of measures used in the literature were applied. Furthermore, pre-testing on the constructs validity was carried out to examine and supports the study. The measures used were reviewed by experts, academicians and professionals on the relevancy and adequacy of the constructs.

(ii) **Convergent validity** is achieved when all the measuring items in a measurement model are statistically significant. The convergent validity was verified by computing the Average Variance Extracted (AVE) for every construct. In order to achieve convergent validity, the value of AVE should be 0.5 or higher. Therefore, retaining the items with low factor loadings in a model could cause the construct to fail convergent validity (Zainudin Awang, 2015)

(iii) **Discriminant Validity** is to indicate that the measurement model of a construct is free from redundant items. In AMOS, items redundancy in the model can be identified through a discrepancy measure, namely, Modification Indices (MI). The high value of MI indicates the items are redundant and in this study, the researcher constrained the redundant pair as "free parameter estimate". Another requirement in discriminant validity is the correlation between exogenous or independent constructs should not exceed 0.85.

Another important assessment on the construct is the Reliability. According to Zikmund, (2003), reliability is defined as the degree to which measures are free from random error and therefore yield consistent results. In other words, reliability is the extent of how reliable is the respective measurement model in measuring the intended latent construct (Zainudin Awang, 2015). In this study, the reliability of measurement model was assessed through Cronbach's alpha, Composite Reliability and Average Variance Extracted.

The Cronbach's alpha is one of the most commonly used indicators to assess reliability (Chua, 2013). The Cronbach's alpha technique estimates the degree to which the items in the scale are representative of the domain construct which have being measured. An alpha coefficient of 0.7 has been used as the minimum acceptable level for determining internal consistency of the scales in this study. In addition, the Composite Reliability (CR) and Average Variance Extracted (AVE) have been used. The Composite Reliability (CR) indicates the reliability and internal consistency of a latent construct (Zainudin Awang, 2015). The study by Bagozzi and Yi (1988) recommended that a value of CR should be equal to or greater than 0.60 in order to achieve composite reliability for a construct. Whereas, the AVE indicates the average percentage of variation explained by the measuring items for a latent construct. An AVE should be equal to or greater than 0.50 for every construct. The CR and AVE values are calculated using formula;

$$AVE = \sum K^2 / n$$

$$CR = (\sum K)^2 / [(\sum K)^2 + (\sum 1\text{-}K)^2]$$

Where, K = *factor loading of every item and,* n = *number of items in a model*

In general, there are two methods used to run the Confirmatory Factor Analysis (CFA) procedures. The first method is to run the CFA procedures by assessing the measurement models separately. Meanwhile, the second method is to run the CFA procedures by pooling all latent constructs in one measurement model and perform CFA at once (Zainudin Awang, 2015). The method is called 'Pooled Confirmatory Factor Analysis (CFA)'. However, according to Zainudin Awang (2015) the pooled CFA method is not possible when the model has too many latent constructs. In this study, the second method (pooled CFA) was used since it is more efficient and could address the concern on model identification problems.

The latent variables of the measurement models are represented in circles and the observed variables are represented in rectangles as shown in Figure 3.7. With CFA, any response items or indicators that do not fit the measurement models due to low factor loading should be removed (Zainudin Awang, 2015). However, the items deletion should not exceed 20% of total items in a model (Zainudin Awang, 2015). If not, the particular construct is considered to be invalid since it failed the "confirmatory" itself. With regard to Figure 3.7, the proposed hypothesis, namely HE-1 to HE-3 for the rail users' travel experience measurement model, HS-1 to HS-6 for the rail users' satisfaction measurement model, HQ-1 to HQ-6 for the perceived service quality measurement model, and HI-1 to HI-9 for the perceived importance measurement model, were examined to ensure that all the indicators are statistically significant. The level of significance is determined through the *p*-values of the path coefficients of these models. Through the Confirmatory Factor Analysis (CFA), the indicators are removed from the models if the relationships are found to be statistically insignificant.

The fitness of the model is then examined using various Fitness Indexes tests. The fitness categories are absolute fit, incremental fit, and parsimonious fit. Although there is no agreement on which fitness indexed should be reported, this study follows the recommendation from Hair et al. (1995), Hair et al. (2010) and Holmes-Smith et al. (2006) to include at least one index from each category of model fit. The proposed model is acceptable and well fitted if the model fitness indices are within the criteria. The goodness-of-fit checking indices for the structural model are tabulated in Table 3.14

Table 3.14: The Index Category and the Level of Acceptance for each Fitness Index

Name of indices and categories	Level of Acceptance	Reference
Absolute fit		
Discrepancy Chi Square, Chisq	p > 0.05, (sensitive to sample size > 200)	Wheaton et al. (1997)
Root Mean Square Error of Approximation (RMSEA)	**RMSEA < 0.08***	**Browne and Cudeck (1993)**
Goodness-of-fit Index (GFI)	**GFI > 0.90***	**Joreskog and Sorbom (1984)**
Incremental fit		
Adjusted Goodness-of-fit Index (AGFI)	AGFI > 0.90	Tanaka & Huba (1985)
Comparative Fit Index (CFI)	**CFI > 0.90***	**Bentler (1990)**
Tucker-Lewis coefficient (TLI/NNFI)	TLI > 0.90	Bentler and Bonett (1980)
Normal Fit Index (NFI)	NFI > 0.90	Bollen (1989)
Parsimonious fit		
Chisq/df	**Chisq/df < 5.0***	**Marsh & Hocevar (1985)**

***The indexes in bold are recommended since they are highly reported in literatures**

According to (Zainudin Awang, 2015), the indices in bold are the recommended goodness-of-fit checking indices since these indices are substantially reported in the literature. The absolute fit index of minimum discrepancy chi-square (Chisq) could be ignored since the sample size for this study is greater than 200 (Hair, 1995; Joreskog and Sorbom, 1996). It was recommended by Hair et al.(1995), Hair et al. (2010) and Holmes-Smith (2006) to use at least three fit indices by including at least one index from each category of model fit. It was observed that the Adjusted Goodness-of-fit Index (AGFI) and Normal Fit Index (NFI) were slightly less than the cut-off value. However, a major disadvantage of Normal Fit Index (NFI) is that it is sensitive to sample size and is an underestimating fit for samples which are less than 200 (Mulaik et al., 1989; Bentler, 1990; Kline, 2005; Hooper and Couglan, 2008). In order to resolve this drawback, the Non-Normed Fit Index (NNFI) or Tucker-Lewis Index (TLI) was developed. This index was preferable because it is one of the fit indices that is less influenced by sample size (Tucker and Lewis, 1973; Bentler and Bonett, 1980).

However, the acceptable and well fitted model could not be attained in the first run. Thus, improvement on the model can be done in two steps. Firstly, the statistical insignificant relationships of measurement models and structural model are removed. Secondly, the possibilities of additional relationships through modification indices are examined. The modification indices (MI) measure the predicted decrease in the chi-square from modifying a particular relationship in a model (Reisinger & Mavondo, 2007). The high values of modification indices (above 15) indicate the correlated errors between response items or indicators. In practical, the relationships with the high modification index are preferred for viable improvement to the structural model. However, the possible additional relationships based on modification indices should be considered carefully with theoretical justification and support from relevant literature. This step is repeated until the acceptable and best fitted model is attained.

3.15 The Importance-Performance Analysis (IPA)

In this study, the questions were focused on access mode service quality to rail transit station in Klang Valley, Malaysia. Throughout the analysis, there are five major modes which have been used as access mode to reach rail station. The access modes are (1) bus, (2) taxi, (3) park and ride, (4) drop-off and (5) walking. The focus group in this study are frequent rail transit users who are travelling with rail at least 8-9 times per week. The respondents were asked to rate their perception on current access mode performance that they used to reach rail station from home. In this study, the performance indicators for each access mode were measured by satisfaction level. The perception on performance (satisfaction) were rated on a five-point Likert scale ranging from 1=strongly dissatisfied to 5=strongly satisfied. In addition, the respondents were also asked to rate their perception on how important each access mode indicators that they used to reach rail station from home. The perception on importance level were rated on a five-point Likert scale ranging from 1= Not at all important to 5=strongly important. There were 37 different access mode indicators listed in the questionnaire. The questions on access mode indicators were divided into five different sections and the respondents were asked to answer the section that was related to their access mode type. The inputs from this information were then analysed using Importance-Performance Analysis method. A common or traditional type of IPA is a two-dimensional matrix as depicted in Figure 3.8. The two-dimensional matrix was constructed by plotting mean ratings of performance and importance in the coordinate system. Importance is presented in the x-axis whereas performance (satisfaction) is presented in the y-axis, which forms four-quadrant matrix. The construction of the four-quadrant matrix is summarized from Wu & Shieh (2009). The effective sample size for each item is assumed as *n*. The mathematical expressions of typical survey results are tabulated in Table 3.15, where there are *k* indicators in the questionnaire, while mean is the sample average and STD is sample standard deviation. Table 3.14 is referred from Wu & Shieh (2009). For the x-axis line (importance), the discussions are as follows; the importance value for each item is calculated by the average value of all respondents from the survey. Hence, the importance value for indicator *i* is,

$$I_i = \sum_{j=1}^{n} x_{ij} / n \qquad (1)$$

where X_{ij} is the value from 1 to 5 by Likert-type scale, where 1 and 5 represent the lowest importance and highest importance, respectively, for *j*th respondent in *i*th indicator for $i = 1,2,3,\ldots,k$ *and* $j = 1,2,3, \ldots, n$. The x-axis line is finally built by,

$$\bar{I} = \sum_{i=1}^{k} I_i / k \qquad (2)$$

Each indicator can be plotted by a pair of values, i.e.,_means of importance and performance. For instance, for item *i*, the pair of values is (I_i,P_i).

The y-axis line (performance) can be drawn as follows: the performance value for each indicator is computed by the average value of all respondents from the survey. Thus, the performance (satisfaction) value for item *i* is,

$$P_i = \sum_{j=1}^{n} y_{ij} / n \qquad (3)$$

where y_{ij} is the value from 1 to 5 by Likert-type scale, where 1 and 5 represent the very dissatisfactory and very satisfactory, respectively, for *j*th respondent in *i*th indicator for $i = 1, 2, 3, \ldots, k$ and $j = 1, 2, 3, \ldots, n$. Finally, the y-axis line is determined by,

$$\bar{P} = \sum_{i=1}^{k} P_i / k \qquad (4)$$

Table 3.15: The example of typical survey results (Wu & Shieh, 2009)

Indicator number	Importance		Performance	
	Mean	Standard Deviation (STD)	Mean	Standard Deviation (STD)
1	I_1	$S(I)_1$	P_1	$S(P)_1$
2	I_2	$S(I)_2$	P_2	$S(P)_2$
3	I_3	$S(I)_3$	P_3	$S(P)_3$
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
I	I_i	$S(I)_i$	P_i	$S(P)_i$
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
K	I_k	$S(I)_k$	P_k	$S(P)_k$
Average	$\bar{I}$	$\hat{S}(I)$	$\bar{P}$	$\hat{S}(P)$

Based on the literature, the four quadrants were referred as Quadrant I: Keep up the good work, Quadrant II: Possible Overkill, Quadrant III: Low Priority and Quadrant IV: Concentrate Here. The four-quadrant matrix is depicted in Figure 3.8. The explanation and definition of these quadrants in IPA are as follows (Deng et al.2008; Wu & Shieh 2009; Grujicic et al., 2014). The indicators located in Quadrant QI: Keep up the good work has the characteristics of both high importance and high level of performance, which are perceived as parameters that can be used to achieve or sustain competitiveness advantage, and the performing of these indicators or components should be maintained and leveraged at the existing level (Deng et al., 2008; Wu et al., 2010). The Quadrant QII: Possible Overkill contains indicators that have high performance but low importance or low priority, which indicates that resources assigned to these attributes are overemphasized and should be assigned to other indicators. Grujicic et al., (2014) stated that the indicators fall into Quadrant II implied that resources allocated to these indicators are too great or in other words possibly over supplied. It was suggested that those resources should be assigned to other indicators or attributes (Grujicic et al., 2014). In addition, Chen and Huang (2011) also stated that no particular actions are needed with respect to the attributes that fall in Quadrant II unless there is pressure in cost which requires action. Quadrant QIII: Low Priority contains indicators that feature both low importance and low performance, and therefore these indicators do not require any additional effort. Research by Wu and Shieh, (2009) considered the indicators which located in Quadrant III as the minor weakness. The indicators in Quadrant QIV: Concentrate Here are of high importance but have poor performance (low customer satisfaction). The indicators which located in this quadrant require immediate improvement efforts because its inability to identify the attributes in Quadrant QIV might resulted in low customer satisfaction. This is why it is necessary to urgently improve the indicators in quadrant QIV and should be placed as a highest priority because those indicators are the major weakness. Meanwhile, indicator in Quadrant QI regarded as major strengths which should be maintained, leveraged, and heavily promoted (Deng et al., 2008; Wu et al., 2010).

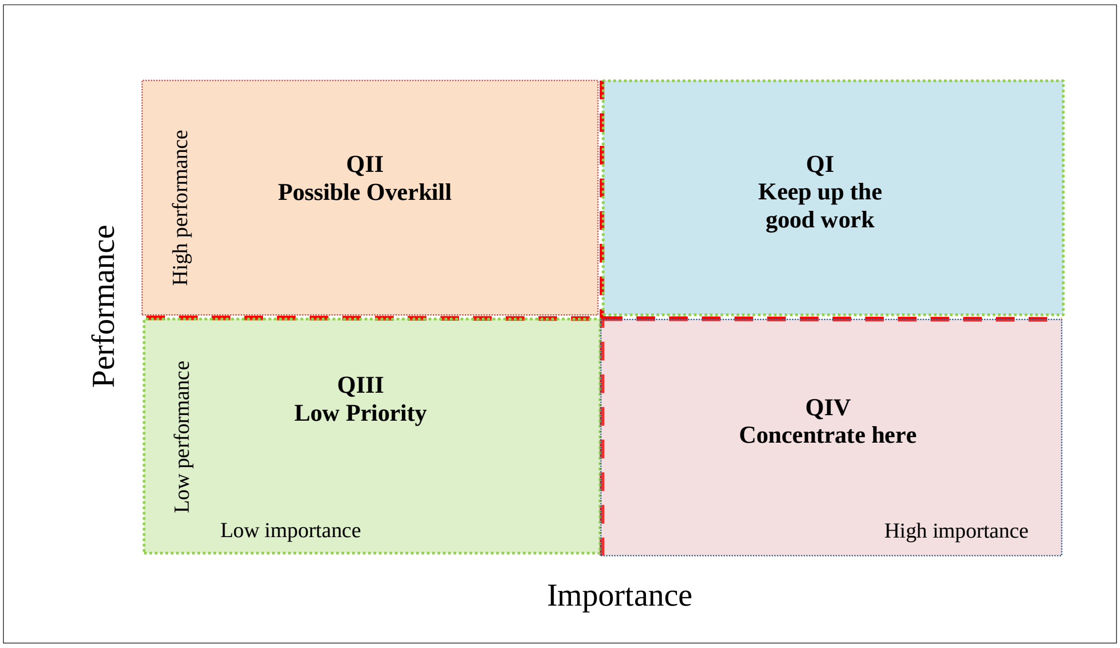

Figure 3.8: Quadrants in Importance-Performance Analysis (IPA)

The traditional Importance-Performance Analysis (IPA) on where the indicators were located depends only upon the average of importance and performance for a particular indicator. However, the point estimation was varied from sample to sample and the consideration of variability or sampling error is not taken into consideration (Ellison et al., 2000; Levine et al., 2005). Therefore, the possibility of the management or service provider to make inappropriate judgement is higher if only point estimates are measured. As a result, Wu and Shieh (2009) introduced the philosophy of using confidence intervals in Importance-Performance Analysis with the aim of reducing the variability and assist the decision maker to make effective judgement on indicators that should be located in the two-dimensional matrix. In addition, IPA method with confidence intervals enables the decision maker to identify the strength and weaknesses based upon the sample size used (Grujicic et al., 2014). The detail on Importance-Performance Analysis (IPA) with integration of confidence intervals is elaborated in the following section.

3.16 Integration of Confidence Intervals and Importance-Performance Analysis

The Importance-Performance Analysis (IPA) with integrated confidence intervals was introduced by Wu and Shieh (2009). In this method, any item or parameters which were located in two-dimensional matrix in the coordinate system were judged and considered to be more effective as compared to traditional IPA. In addition, IPA with confidence intervals enables the decision maker to identify the strength and weaknesses based upon the sample size used (Grujicic et al., 2014). The confidence intervals display the range in which the population parameter will be the most likely. The 95% confidence level is set in IPA. The construction of the IPA integrated with confidence intervals started by calculating the average value of importance level for *k* indicators using equation (1) and followed by building the importance-axis line (x-axis) using equation (2). The building of performance-axis line (y-axis) applied similar steps as importance-axis line (x-axis) by using equation (3) and (4). Two assumption of variance was considered in integrated IPA with confidence intervals calculation. Those assumptions are (1) equal and (2) unequal population variances. If the population variance for each indicator is assumed to be equal, the pooled sample standard deviation estimate of importance (x-axis), $\hat{S}(I)$ and performance (y-axis), $\hat{S}(P)$ is as follows (Levine et al., 2005);

$$\hat{S}(I) = \frac{\sum_{i=1}^{k} S(I)_i}{k} \qquad (5)$$

$$\hat{S}(P) = \frac{\sum_{i=1}^{k} S(I)_i^2}{k} \qquad (6)$$

Meanwhile, if unequal population variances assumption exists, which is very common or usual, the sample standard deviation estimate of importance (x-axis), $\hat{S}(I)$ and performance (y-axis), $\hat{S}(P)$ is as follows (Rencher, 2002);

$$\hat{S}(I) = \frac{\sqrt{\sum_{i=1}^{k} S(I)_i}}{k} \tag{7}$$

$$\hat{S}(P) = \frac{\sqrt{\sum_{i=1}^{k} S(P)_i^2}}{k} \tag{8}$$

Where k is number of indicators, $S(I)_i$ is mean of importance indicators and $S(P)_i$ is mean of performance indicators.

In this study, the sample size, n is larger than 30, therefore, the Central Limit Theorem can be applied to construct a (1-α)% confidence interval for importance-axis line (x-axis) and performance-axis line (y-axis). If the population variance for each indicator in importance and performance is assumed to be equal, a (1-α)% confidence interval is written as follows (Levine et al., 2005);

$$\bar{I} \pm Z\frac{\propto}{2}\frac{\hat{S}(I)}{\sqrt{n}} = \left\{\bar{I} \pm Z\frac{\propto}{2}\,\frac{\sum_{i=1}^{k} S(I)i}{k\sqrt{n}}\right. \tag{9}$$

$$\bar{P} \pm Z\frac{\propto}{2}\frac{\hat{S}(P)}{\sqrt{n}} = \left\{\bar{I} \pm Z\frac{\propto}{2}\,\frac{\sum_{i=1}^{k} S(P)i}{k\sqrt{n}}\right. \tag{10}$$

Therefore, if unequal population variances assumption is used, a (1-α)% confidence interval is written as follows (Rencher, 2002);

$$\bar{I} \pm Z\frac{\propto}{2}\frac{\hat{S}(I)}{\sqrt{n}} = \left\{\bar{I} \pm Z\frac{\propto}{2}\sqrt{\frac{\sum_{i=1}^{k} S(I)_i^2}{k^2.n}}\right. \tag{11}$$

$$\bar{P} \pm Z\frac{\propto}{2}\frac{\hat{S}(P)}{\sqrt{n}} = \left\{\bar{I} \pm Z\frac{\propto}{2}\sqrt{\frac{\sum_{i=1}^{k} S(P)_i^2}{k^2.n}}\right. \tag{12}$$

Where the value of $Z\frac{\propto}{2}$ is dependent on confidence level set by the researcher, $\bar{I}$ is the sample mean of importance indicators, $\bar{P}$ is the sample mean of performance indicators and $\frac{\hat{S}(I)}{\sqrt{n}}$, $\frac{\hat{S}(P)}{\sqrt{n}}$ is standard error of importance and performance indicators mean respectively. In the analysis, confidence interval is specified at the 95% confidence level. Confidence interval of 95% means there is 95% confidence level that similarly constructed interval will contain the estimate parameter.

Based on the above equations, the four quadrants matrix as depicted in Figure 3.8 are divided into nine areas which was separated by four dotted lines as shown in Figure 3.9. The four dotted lines are calculated from lower and upper confidence limits.

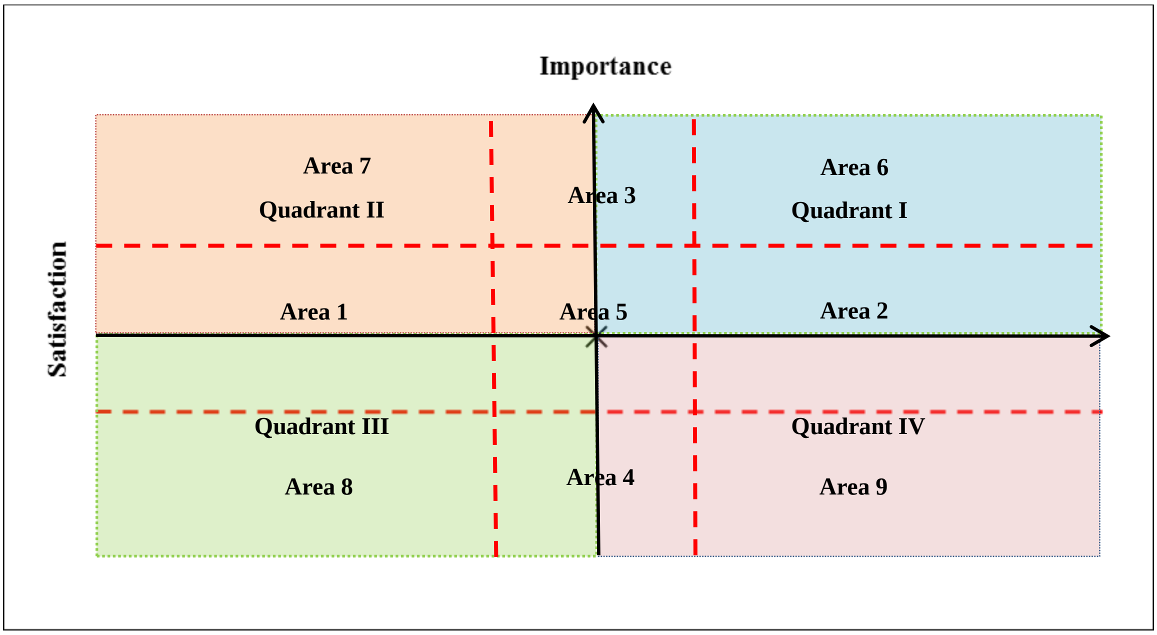

Figure 3.9: The Importance-Performance Analysis with Confidence Intervals Integration

Based on Figure 3.9, it was depicted that the points which originally plotted in Quadrant I: Keep up the good work might not be necessarily considered as the strength due to confidence intervals integration. This is because, if the points are located in Area 3, it would be difficult and undetermined to summarize whether the indicators belong to

QI: Keep up the good work or QII: Possible overkill. In addition, if the points fall in Area 2, it cannot be determined whether the indicators belong to either QI: Keep up the good work or QIV: Concentrate here. Moreover, the points plotted in Area 5 would be difficult and undetermined to summarize whether the indicators should be classified in QI: Keep up the good work, or QII: Possible overkill or QIII: Low priority or QIV: Concentrate here, because of the sampling errors (Wu & Shieh, 2009). It was determined that only the points in Area 6, Area 7, Area 8 and Area 9 can be solely considered as Q1: Keep up the good work, Q2: Possible overkill, Q3: Low priority or Q4: Concentrate here . In the analysis, the IPA plot for 95% confidence interval with equal and unequal population variances assumption will be discussed in Chapter 4: Results and Discussion.

3.17 Chapter Summary

In this chapter, research methodologies and analysis were explained. In the first part, the questionnaire designs as well as data collection method are described. The research involved two types of respondents, namely, (1) frequent rail users and (2) private transport users in Klang Valley (KV), Malaysia. The respondents need to answer the same questions at the beginning and after that, the respondents have to answer inquiries that is related to their travel mode. In the second part, three difference methodologies to analyse the data was presented. Those methods were; (1) Binomial Logistic Regression analysis, (2) The Structural Equation Modelling (SEM) Approach and (3) The Importance-Performance Analysis (IPA) with Integrated Confidence Intervals. For frequent rail users, the Binary Logit models will be used for questions with one answer from a choice of two, whether (1) rail transit or (2) private transport, in order to compare them for the factors that favour private transport use. For private transport users, the Binary Logit models will be used for questions with one answer from a choice of two, whether (1) private transport or (2) rail transit, in order to compare them for the factors that favour rail use. The

Importance-Performance Analysis (IPA) with integrated confidence intervals will be applied to identify the access modes attributes that are priorities for enhancement and thus allow for the implementation of direct strategies, which will be based on the service quality performance. The Structural Equation Modelling (SEM) approach will be applied to investigate and develop the structural model for the perceived importance of rail transit system.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter is focusing on data analysis. The analysis involves is the descriptive statistics to identify the access and trip pattern of frequent rail users and private transport users. The willingness of frequent rail users and private transport users to shift to other travel mode is measures by the Binomial Logistic Regression method. The evaluation on the current access modes facilties is measures by Importance-Perfromance Analysis (IPA) approach and the development of structural model for perceived importance of the rail transit system traits is measures through structural equation modelling (SEM). The discussions on the findings will also be elaborated in this chapter.

4.2 Data characteristics

In this chapter, results for both respondents, namely frequent rail users and private transport users (which have rail transit experiences) will be presented and discussed.

Throughout this study, 573 survey responses were collected. However, after screening, 14 incomplete responses were discarded. Thus, the survey responses of rail and private transport users are from 559 respondents (97.6% acceptance rate). This number has fulfilled the minimum of 384 responses needed to achieve 95% confidence level and 5% margin of error for population sizes of 100 million and below (Krejcie & Morgan, 1970). From initial analysis, it was found that 58.1% of the respondents are frequent rail transit users and 41.9% of the respondents are private users.

In this study, the Revealed Preference (RP) and Stated Preference (SP) methods are used to evaluate the travel mode choice parameters. The RP questions were constructed to attain data on the trip diaries, current travel behaviour and socio-demographic background of the respondents. The SP questions were designed to obtain information on travel mode choices among frequent rail transit users and private transport users over a series of hypothetical travel scenarios. The SP approach is used in order to assess how frequent rail transit and private transport users will react to hypothetical travel scenarios and make choices between travel modes in much the same way as they might do when making choices in real situation.

4.3 Revealed Preference (RP) Survey Data

4.3.1 The Socio- Demographic Characteristics

The analysis on demographic and socio-economic characteristics is significant in order to design viable rail travel policies, that sufficiently fulfil specific target groups requirement. Socio-economic characteristics of travellers are crucial in influencing daily travel mode choice as travellers with wider demographic and socio-economic interaction will have higher travelling capabilities that will influence the frequency, approach and involvement of certain travel mode on their daily activities (Limtanakool et al., 2006).

In this study, gender, ethnicity, nationality, age, marital status, monthly income, location origin and education represent the socio-economic background. Availability of driving license, vehicle ownership and frequency of travel using rail represent the travelling capabilities of the respondents. Job status and trip purpose represent the activities interaction of the respondents. Table 4.1 showed the distribution of frequent rail and private transport users based on socio-demographic characteristics.

Table 4.1: Distribution of Socio-Demographic Characteristics for Frequent Rail Users and Private Transport Users

Variables	Percentage (%)		
	Overall	Frequent Rail Users (325 respondents)	Private Transport Users (234 respondents)
Gender			
Male	51.2	46.8	57.3
Female	48.8	53.2	42.7
Ethnicity			
Malay	61.2	58.2	65.4
Chinese	22.0	23.4	20.1
Indian	9.5	11.4	6.8
Others	7.3	7.0	7.7
Nationality			
Malaysian	93.2	93.2	93.2
Non-Malaysian	6.8	6.8	6.8
Age			
18-24	36.0	39.4	31.2
25-30	30.2	29.8	30.8
31-40	17.2	17.2	17.1
41-50	9.5	7.4	12.4
51-60	5.5	4.9	6.4
61 and above	1.6	1.2	2.1
Marital status			
Single	62.6	66.8	56.8
Married, no kids	7.5	8.0	6.8
Married, have kids	27.6	22.8	34.2
Others	2.3	2.5	2.1
Job status			
Pensioner/Housewives/Part-time job	7.0	5.5	9.0
Student	21.8	29.5	11.1
Blue collar(skilled/semi-skilled/unskilled)	15.0	12.3	18.8
White collar (e.g. clerk, typist, etc.)	18.2	20.3	15.4
Self-employed/Businessman	5.0	2.5	8.5
Management & Executive	12.1	9.5	15.8
Professional	20.8	20.3	21.4
Monthly income			
Less or equal to RM1000	29.5	32.6	25.2
RM1001 - RM2000	22.0	22.2	21.8
RM2001 - RM3000	19.9	18.5	21.8
RM3001 - RM4000	12.7	12.6	12.8
RM4001 - RM5000	5.0	3.1	7.7
More or equal to RM5001	10.9	11.1	10.7
Licensed driver			
No	20	27.4	9.8
Yes	80.0	72.6	90.2

‘Table 4.1, continued’

Variables	Percentage (%)		
	Overall	Frequent Rail Users (325 respondents)	Private Transport Users (234 respondents)
Vehicle ownership			
No vehicle available	24.1	41.5	0
Vehicle available	75.9	58.5	100
Availability of vehicle (per household)			
1	84.2	80.9	88.9
2	14.9	18.5	9.8
3	0.9	0.6	1.3
Highest education			
Primary/Secondary School	24.7	24.9	24.4
Pre-University/Diploma	25.9	25.8	26.1
Degree	39.3	40.3	38.0
Postgraduate (Master/PhD)	10.0	8.9	11.5
Travel purpose			
Work trip	69.8	62.8	79.5
Other purpose (Education /Social/Personal)	30.2	37.2	20.5
Number of trips with rail transit			
8-9 trips per week	16.5	28.3	-N/A-
10-11 trips per week	37.0	63.7	-N/A-
> 12 trips per week	4.7	8.0	-N/A-
Number of trips with rail transit			
At least once a month	32.6	-N/A-	77.8
Once in two months	9.3	-N/A-	22.2

Table 4.1 presented the distribution of 559 participants with 325 of them are frequent rail users and 234 are private transport users. In overall, male users (51.2%) are slightly dominant proportion as compared to female users (48.8%). It was also found that Malay (61.2%) form the majority and more than 90% of respondents are Malaysian. Considering the age groups, younger riders (66.2%) in the range of 18-30 years old are the dominant respondents. Also, the majority of respondents are single (62.6%). In overall, respondents in professional fields are slightly dominant in comparison to compared to other job areas. Additionally, the monthly income of respondents are evenly distributed among three income groups, namely, less than RM1000 (25.2%), between RM1001 – RM2000 (21.8%) and between RM2001 - RM3000 (21.8%). In overall, 80.0% of the respondents have driving license and interestingly about 9.8% of the private transport users owned

vehicles even though they have no license. It was also discovered that all of the frequent rail users have available vehicle as an alternative mode for their journey either of their own or their household vehicles. All of the respondents were at least have primary or secondary school qualification with respect to educational levels with majority of them have degree qualification. Predominantly, the respondents travelled daily for working purposes.

From Table 4.1, as for frequent rail users, it was found that the percentage of females using rail transit frequently are slightly higher (6.4% difference) than males. With respect to race, the Malays (58.2 %) form the majority of frequent rail transit users. More than two third of the frequent rail users are Malaysian (93.2%). It was found that majority of frequent rail transit users are younger riders, aged between 18 to 30 years old (69.2%). As the age increased, the percentage of respondents travel with rail transit frequently became lesser. It was observed that only 6.1% of respondents aged 51 years old and above are the frequent rail users. As for marital status, more than half (66.8%) of frequent rail transit users are single. As for employment, white-collar job (20.3%), professional (20.3%) and students (29.5%) are the frequent users of rail transit system, which contribute to 70.1%. As for monthly income, up to 67.4% of the frequent rail transit users have monthly income of more than RM1000 per month and 27.4% of the respondents do not have a driving license. It was found that 58.5% of the frequent rail users owned a vehicle and 19.1% of the households owned more than one vehicle. It was found that majority (66.1%) of the frequent rail transit users have degree and pre-university or diploma qualifications. About 62.8% of the frequent rail user travel for work and 37.2% of them travel with rail for education, social and personal purpose. Majority of the frequent rail users were travelled between 10-11 trips per week (63.7%).

The socio- demographic characteristics of private transport users, which have experiences using rail transit were also discussed in Table 4.1. As contradict to frequent rail users, the percentage of females travel with private transport are lower (14.6% different) than males. With respect to race, the Malays (65.4%) form nearly two third of the private transport users. It was also found that more than two third of the private transport users are Malaysian (93.2%). Similarly, with frequent rail users, it was found that majority of private transport users are younger riders, aged between 18 to 30 years old (62.0%). As per marital status, more than half (56.8%) of private transport users are single. As for job types, the majority of private transport users are working as professionals (21.4%) followed by blue-collar jobs (18.8%). The survey results have a slightly higher percentage (74.8%) of private transport users with monthly income of more than RM1000 per month as compared to frequent rail users. About 9.8% of the private transport users do not have a driving license. However, it was found that 100% of the private transport users have vehicles for their travel. The survey results also showed a higher percentage (49.5 %) of private transport users with degree and postgraduate qualifications. Approximately, 79.5% of the private transport users travel for work and educational purpose and only 20.5% of them travel with private transport for education and other purposes.

4.3.2 Travel Characteristic of Frequent Rail Users

The travel characteristic data referred to the related information regarding daily trip from home (origin) to final destination, namely workplace or university. For the purpose of this study, the travel characteristic data were overall travel time, overall travel cost, overall travel distance, access cost, access time, access distance, access mode, departure time from home and arrival time. In this study, access cost is referred to current out-of-pocket expenditure from home to rail station. The access time is defined as the time taken by frequent rail users to reach rail transit station from home. The access distance is defined as the length from respondent's home to rail transit station. While, travel cost is referred to current out-of-pocket expenditure from home to final destination and also for the return journey. The travel time is referred as the time taken by frequent rail users from home to final destination and also for the return journey. In this study, travel distance is defined as the total length from origin (respondent's home) to the final destination (workplace/university/other places) and the return journey. Table 4.2 showed the distribution of daily travel characteristic of frequent rail users in Klang Valley.

Table 4.2: Distribution of daily travel characteristic of frequent rail users

Travel characteristic	**Category**	**Proportion (%)**
Journey frequency using rail (per week)	8-9 trips	28.3
	10-11 trips	63.7
	12 trips	8.0
Residential area	Klang Valley	98.8
	Outside Klang Valley	1.2
Access mode from home to station	Walking	33.8
	Taxi	13.5
	Bus	15.1
	Park and Ride	19.7
	Drop-off/Pick-up	17.8
Access cost from home to station (*include/exclude walking*)	RM0-RM1.90	59.4/38.6
	RM2.00-RM3.90	26.5/40.0
	RM4.00-RM5.90	12.6/19.1
	RM6.00-RM7.90	1.5/2.3
	Average access cost	RM1.30/RM2.30
	Standard Deviation, SD	0.770/0.807
	Min	RM0.00/RM1.00
	Max	RM6.40/RM6.40
Access time from home to station	0-10 minutes	58.2
	11-20 minutes	32.0
	21-30 minutes	8.3
	31-40 minutes	1.2
	41-50 minutes	0.3
	Average access time	12.0 minutes
	Standard Deviation, SD	0.726
	Min	3.0 minutes
	Max	45.0 minutes

'Table 4.2, continued'

Travel characteristic	Category	Proportion (%)
Access distance from home to station	0-500m	24.6
	501-1000m	12.3
	1001-1500m	5.2
	1501-2000m	18.8
	More than 2000m	39.1
	Median of access distance	1250.5 meters
	Standard Deviation, SD	1.656
	Min	0-500m
	Max	More than 2000m
Overall travel cost from home to final destination (including return trip)	RM0-RM1.90	2.0
	RM2.00-RM3.90	14.7
	RM4.00-RM5.90	22.0
	RM6.00-RM7.90	21.6
	RM8.00-RM9.90	13.9
	RM10.00-RM11.90	9.8
	RM12.00-RM13.90	4.9
	RM14.00-RM15.90	4.9
	RM16.00-RM17.90	4.9
	RM18.00-RM19.90	1.20
	Average travel cost	RM7.60
	Standard Deviation, SD	1.998
	Min	RM 1.40
	Max	RM 19.40
Overall travel time from home to final destination (including return trip)	11-20 minutes	0.8
	21-30 minutes	3.7
	31-40 minutes	2.0
	41-50 minutes	6.9
	51-60 minutes	8.2
	61-70 minutes	9.4
	71-80 minutes	10.2
	81-90 minutes	11.4
	91-100 minutes	9.8
	> 100 minutes	37.6
	Average travel time	91 minutes
	Standard Deviation, SD	2.621
	Min	20 minutes
	Max	160 minutes
Overall travel distance from home to station (including return trip)	0-10km	1.6
	11-20km	33.9
	21-30km	32.2
	31-40km	11.8
	More than 40km	20.4
	Median of travel distance	25.5 km
	Standard Deviation, SD	1.114
	Min	0-10km
	Max	More than 40km
Available alternative	No alternative	0.0
	Bus	20.0
	Taxi	23.4
	Private transport	56.6

From Table 4.2, majority (63.7 %) of frequent rail users travelled between 10-11 trips per week. The trips included the start and return journey of frequent user by rail for over a week. There are five access mode choices used by frequent rail users in this study: (1) walking, (2) bus, (3) taxi, (4) park and ride, and (5) drop-off & pick-up. The mode share shows that majority of frequent rail transit users are walking (33.8%) from home to rail transit station. The park and ride (19.7%) was the second most access mode choice followed by drop-off & pick-up (kiss and ride) (17.8%), bus (15.1%) and taxi (13.5%).

With respect to the objectives of this study, the accessibility and travel daily attributes using rail transit were obtained and analysed. The accessibility and travel daily attributes referred to access cost, access distance, access time, overall travel cost, overall travel distance and overall travel time. Two different access cost values were recorded, namely access cost which included walking as access mode and access cost without walking as access mode. In average, frequent rail users spent RM1.30 (included those who are walking to rail station from home) and RM2.30 (excluded those who are walking to rail station from home) for their access cost. By excluding those who are walking to rail station from home, there were 61.4% of the frequent rail users spent RM2.00 and above for their access cost.

With respect to access time, frequent rail transit users taking in average 12 minutes to reach rail station from home. Approximately, about 41.8% of frequent rail users taking more than 10 minutes to reach rail transit station from home. About 63.1% of the frequent rail transit users are living more than 1000m from rail transit station. Interestingly, walking from home to rail station was the sole access mode used by frequent rail users for access distance of less than 1000m. In other words, the use of public transport and motorized access modes was inclined to access distance of more than 1000m.

In average, frequent rail users spent RM7.60 for their overall travel cost from home to their final destination and the return journey. About 5.8% of frequent rail users spent more than RM15.00 on their daily travel cost (including the return journey). It was discovered that majority of frequent rail users who are spending more than RM15.00 for their travel cost used a taxi as their access mode from home to the station. Currently, the flag fall taxi fixed rate in Klang Valley area for the first kilometres or first 3 minutes is in the range of RM3.00 (budget taxi) until RM6.00 (executive taxi). The flag fall was the main contributor for high overall daily travel cost of frequent rail users who used taxi as their access mode. In addition, there were 78.4% of frequent rail users that take more than 60 minutes to travel from home to final destination and for the return journey. In average, the overall travel time of frequent rail users to travel from home to final destination was 91 minutes.

Other than that, about 32.2% of frequent rail users travelled more than 30 km per day from home to final destination and for the return journey. It was discovered that majority (56.6%) of frequent rail users will use private transport as an alternative travel mode if rail was not chosen as their daily travel choice. Through cross-tabulation, it was found that 46.4% of frequent rail users who walked to station would use their private transport as their alternative travel mode. In addition to that, approximately 43.4% of frequent rail users were still considering another public transport, namely, bus and taxi, as their alternative daily travel mode.

4.3.3 Travel Characteristic of Private Transport Users

For private transport users, Table 4.3 depicted the distribution of daily travel characteristic of private transport users in Klang Valley.

Table 4.3: Distribution of Daily Travel Characteristic of Private Transport Users

Travel characteristic	Category	Proportion (%)
Journey frequency using rail	At least once a month Once in two months	77.8 22.2
Journey frequency using private transport to work per week (including the return journey)	9-10 trips 11-12 trips	69.2 30.8
Access mode from home to station if they use rail	Walking Taxi Bus Park and Ride Pick-up/Drop-off	16.7 5.1 10.7 50.0 17.5
Access cost from home to station (include/exclude walking)	RM0-RM1.90 RM2.00-RM3.90 RM4.00-RM5.90 RM6.00-RM7.90 RM8.00-RM10.00 *Average access cost* *Standard Deviation, SD* *Min* *Max*	29.1/14.9 65.8/79.0 0.4/0.5 3.0/3.6 1.7/2.1 RM2.20/2.70 0.735/0.696 RM0.00/1.00 RM9.00/9.00
Access time from home to station	0-10 minutes 11-20 minutes 21-30 minutes 31-40 minutes 41-50 minutes *Average access time* *Standard Deviation, SD* *Min* *Max*	35.9 59.0 5.1 0.0 0.0 15.0 minutes 0.563 5 minutes 30 minutes
Access distance from home to station	0-500m 501-1000m 1001-1500m 1501-2000m More than 2000m *Median of access distance* *Standard Deviation, SD* *Min* *Max*	18.4 9.8 6.4 23.9 41.5 1750.5m 1.542 0-500m More than 2000m

‘Table 4.3, continued’

Travel characteristic	Category	Proportion (%)
Overall travel cost from home to final destination (including return trip)	RM0-RM1.90	0.0
	RM2.00-RM3.90	0.0
	RM4.00-RM5.90	17.5
	RM6.00-RM7.90	7.7
	RM8.00-RM9.90	5.1
	RM10.00-RM11.90	11.1
	RM12.00-RM13.90	3.8
	RM14.00-RM15.90	9.8
	RM16.00-RM17.90	8.1
	RM18.00-RM19.90	3.8
	≥ RM20.00	32.9
	Average travel cost	RM15.40
	Standard Deviation, SD	3.096
	Min	RM4.00-RM5.90
	Max	≥ RM20.00
Overall travel time from home to final destination (including return trip)	0-10 minutes	0.0
	11-20 minutes	0.0
	21-30 minutes	14.5
	31-40 minutes	4.7
	41-50 minutes	6.0
	51-60 minutes	0.0
	61-70 minutes	5.6
	71-80 minutes	12.0
	81-90 minutes	4.7
	91-100 minutes	10.3
	101-110 minutes	0.9
	111-120 minutes	12.4
	121-130 minutes	5.6
	131-140 minutes	5.1
	141-150 minutes	8.1
	151-160 minutes	3.8
	> 160 minutes	6.4
	Average travel time	97 minutes
	Standard Deviation, SD	4.437
	Min	21-30 minutes
	Max	> 160 minutes
Overall travel distance from home to station (including return trip)	0-10km	16.7
	11-20km	21.8
	21-30km	16.7
	31-40km	19.7
	More than 40km	25.2
	Median of travel distance	25.5
	Standard Deviation, SD	1.441
	Min	0-10km
	Max	More than 40km
Available alternative	No alternative	0.0
	Bus	10.7
	Taxi	5.1
	Rail	84.2

From Table 4.3, the majority (69.2 %) of private transport users travelled between 9-10 trips per week. The trips include the start and return journey of private transport users for over a week. In this study, the private transport users had previously experiencing travelling by rail transit. Although they used private transport as their daily travel mode, their opinions on previous experiences travelling by rail were collected and discussed.

It was discovered that about 77.8% of private transport users travelled by rail at least once a month and about 22.2% of them used rail once in two months. As expected, park and ride facility was the major (50%) access mode that private transport users choose when they travelled by rail seldomly. The use of public transport, namely, bus and taxi showed lower preference as compared to other modes. Two different access cost values were recorded, namely (1) access cost value, which included walking as access mode, and (2) access cost value without walking as access mode. In average, private transport users spent RM2.20 (included those who are walking to rail station from home) and RM2.70 (excluded those who are walking to rail station from home) for their access cost when travelled with rail. By excluding those who are walking to rail station from home, it was discovered that private transport users spent 23.7% more than frequent rail users when they travelled with rail. In average, private transport users took 15 minutes to reach rail station from home as compared to frequent rail users. It was also found that more private transport users, i.e. 22.1% higher than frequent rail users, took more than 10 minutes to reach rail station from home. Majority of private transport users (41.5%) stayed in access distance of more than 2km from rail station. This situation explained the higher usage of park and ride mode among private transport users when they travelled by rail transit.

As for the cost, the private transport users spent RM15.40, which was RM7.80 higher than frequent rail on their daily travel cost (including the return journey). In other words, the private transport users spent RM7.70 per day for one-way trip from home to final destination. Apart of fuel cost, the highway toll fare was also included in travel cost calculation. In Klang Valley area, the highway toll fare varied according to the vehicles, coming in and out location. The higher toll fare was most likely the biggest factor that influence daily travel cost of private transport users.

With regard to travel time, 74.8% of the frequent rail users took more than 60 minutes to travel from home to final destination as well as for the return journey. In average, the overall travel time was 97 minutes, which was 8 minutes higher than frequent rail users. Interestingly, about 6.4% of private transport users travelled more than 160 minutes per day from home to final destination and for the return journey. In other words, the private transport users travelled more than 80 minutes for one-way trip from home to their final destination.

In addition to that, as for access distance, it was discovered that majority of private transport users travelled more than 40km for their trip to and from the destination. In overall, it was quite encouraging to discover that nearly 85.0% of private transport users will use rail as their alternative daily travel mode. On the contrary, the use of other public transport, namely, bus (10.7%) and taxi (5.1%) depicted lower preference as compared to rail. For the application of Binomial Logit Model analysis, the average value of access cost (exclude walking), average value of access time, median value of access distance, average value of travel cost and average value of travel cost will be used in order to estimate the probability of shifting to rail or private transport under different travel scenarios.

4.3.4 Access Trip Characteristics of Frequent Rail Users

Access trip characteristic included access mode share, access time, access cost and access distance from home (origin) to their final destination (workplace/university/other places). Whereas, overall trip characteristics included travel time, travel cost and travel distance from home (origin) to their final destination (workplace/university/other places). The analysis and findings of access mode share on different access and overall trip characteristics will be presented in subsequent sub-sections.

4.3.4.1 Access Mode Share of Frequent Rail Users

It was discovered that there were five access mode used by frequent rail users to reach rail station from home. Those access modes were walking, taxi, bus, park and ride, and drop-off/pick-up. The access mode share used by frequent rail users is presented in Figure 4.1.

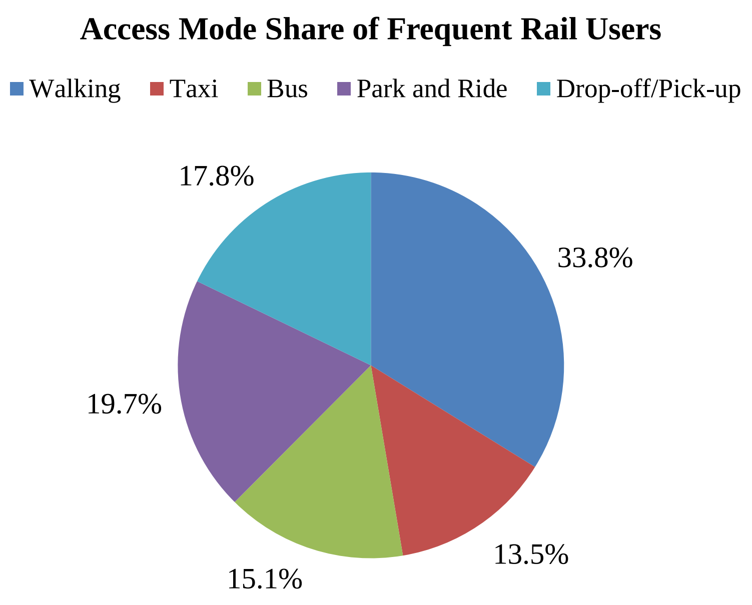

Figure 4.1: Access Mode Share of Frequent Rail Users in Klang Valley

As presented in Figure 4.1 and Table 4.2, walking to rail station was the dominant access mode among frequent rail users in Klang Valley with the percentage of 33.8%. The research in other emerging countries by Wibowo (2007) and Netipunya (2006) also found that walking (Bangkok = 37.0% and Manila =36.0%) is a dominant access mode to rail station in Bangkok and Manila, respectively. Other than that, park & ride as well as drop-off (kiss & ride) was the second (19.7%) and third (17.8%) most access mode used by frequent rail users. The high vehicle ownership among frequent rail users are most likely is the factor,that influenced their access mode decision. While, the use of public transport, namely, bus and taxi showed lower preference in Klang Valley area, bus (15.1%) and taxi (13.5%) was the fourth and fifth access mode that was used by frequent rail users. In comparison, to the other Asian urban cities, about 14.0% and 3.0% of the travellers in Bangkok and Manila are using bus as their access mode to rail station, respectively (Wibow & Chalermpong, 2010). Other than that, motorcycle taxi (31.0%) and 'jeepney' (34.0%) was found to be the second dominant access in Bangkok and Manila. The motorcycle taxis preferable in Bangkok because it can travel through narrow streets thus take shorter route and able to avoid congested areas.

As for Manila, because of the same reason, jeepney was the one that dominate the public transportation services thus indirectly influenced the access mode choice of travellers. In another study, Rastogi and Rao (2003) stated that nearly 50% of commuters in Mumbai, India accessed the train station by walking. While, Givoni and Rietvield (2007) in their study in Netherlands, stated that cycling, public transport and walking are the main chosen modes for those within 3km from rail station. These are due to the reasonable access distance from home to rail station and good qualities of transport network planning in the Netherlands. As for in Hong Kong, the public light buses and taxis are also provided to supplement the feeder services for the users to reach rail station (Lau and Chiu, 2003).

4.3.4.2 Access Distance of Frequent Rail Users

It was widely understood that the performance of a public transportation system would be affected mainly by the proximity of public transport stops to the regional population (Halden et al., 2000; Wibowo, 2005). One of the important attributes with respect to proximity is the effect of access distance from home to public transport services. The relationship between access mode share and access distance to rail transit station in Klang Valley area is presented in Figure 4.2.

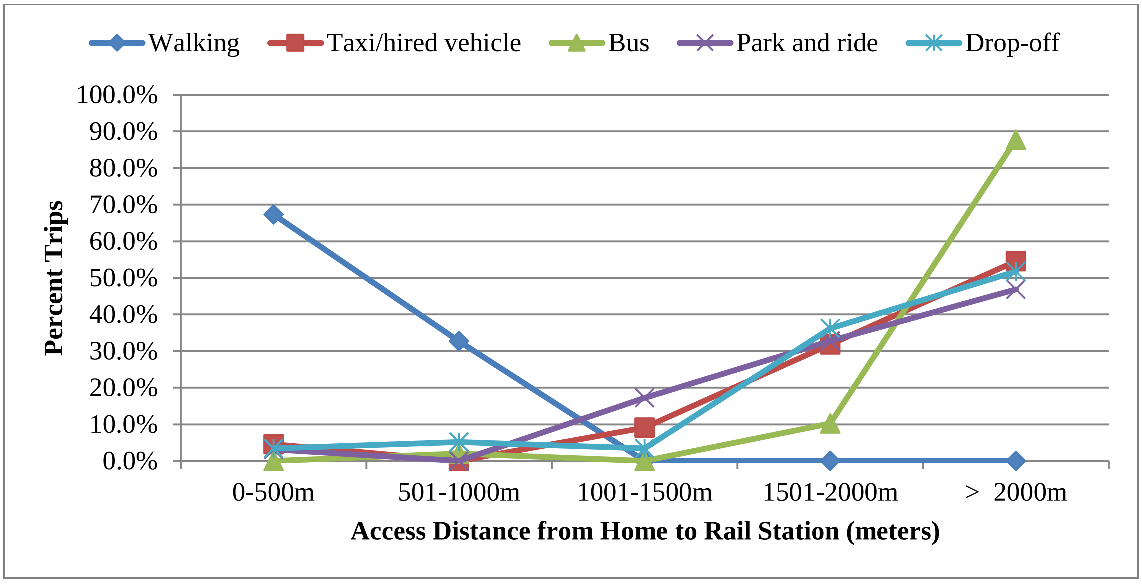

Figure 4.2: Relationship between Access Mode Share and Access Distance to Rail Transit Station in Klang Valley

Walking to rail station was a dominant mode for an access distance of lesser than 1000 metres. There were no respondents walked for the access distance of longer than 1000 metres. As expected, the use of motorized access mode, namely bus, taxi and private transport increased as the access distance to rail station increased. The access mode from home to station distribution is different for those who live up to and more than 1000 metres from the station. The distance highly influences the access mode choice as showed by a trade-off between shorter walking distance and the usage of public transport as the distance increases. It was also revealed that bus and taxi (20.6%) became a popular mode for an access distance of more than 2000 metres from the rail station. It can be seen that walking to rail station is the most preferable over a short distance. However, the access distance had a negative effect on a walking to rail station. This is because the longer the access distance from rail station, the less likely the travellers to walk.

As compared to other studies in the South East Asian region, namely Bangkok and Manila, it was discovered that less than 10% of the respondents walk for more than 1000 metres and none of the respondents walk for a distance more than 2000 metres (Wibowo, 2007; Netipunya, 2006). Apparently, the maximum acceptable walking distance varies in different locations and different countries (Bergman et al., 2011; Wibowo, 2007). In this study, the median value of access distance to rail station using different access modes was 1250.5 meters. Whereas, the median value of access distance for walking mode was 500 meters. About 67.3% of frequent rail users lived within 500 meters from rail transit station choose walking as their access mode and 32.7% of them lived outside 500 meters walked to the rail station. In this study, the median value of 500 meters will be suggested as a demarcation line of walking mode with other access modes to the rail station in Klang Valley. This finding liaises with National Key Performance Indicators (NKPI) for Urban Rail Development Plan (URDP) of Klang Valley, (Land Public Transport Commission, 2013b). The indicator was to increase the percentage of the population residing within walking distance of public nodes from 63% in 2010 to 75% in 2015. In other words, the URDP was implemented to serve each transit stop by a walking catchment, namely, 400 metres if outdoors and over 400 metres if indoors or under cover. In addition, the transit stops would also be supported by a feeder bus network. Based on current official data, this indicator are 72% achieved in 2012.

Conclusively, the role of access distance as one of the prominent accessibility attributes is undeniable. The acceptable walking distance to public transport services should be highlighted in the housing development and new rail transit stop planning as it will influence the commuters' access mode choice in the future. According to Murray et al., (1998), the particular travel mode is unlikely to be utilized if the distances to access the service are too far at either the trip origin or destination.

4.3.4.3 Access Time of Frequent Rail Users

In this study, the access time is referred to the time taken by frequent rail users to reach rail transit station from home. The frequent rail users took about 5 to 45 minutes to reach rail station from home by using different access mode. The relationship between access mode share versus access time is shown in Figure 4.3.

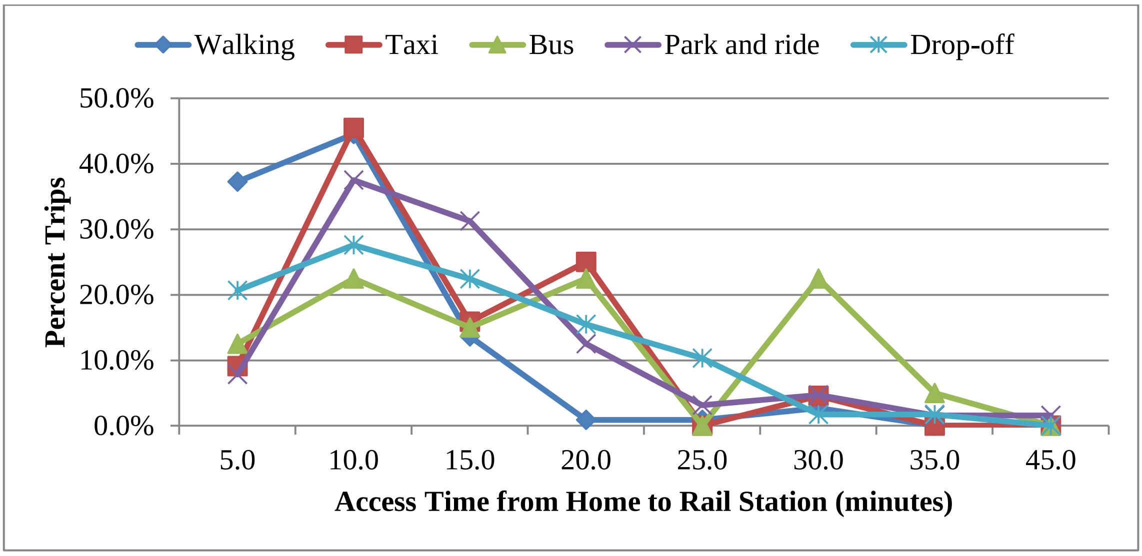

Figure 4.3: Relationship Between Access Mode Share and Access Time to Rail Transit Station in Klang Valley

It can be noted that the distribution trends for walking and drop-off, taxi and park and ride are similar in nature. In average, the access time of frequent rail users in Klang Valley area was 12.0 minutes. Rastogi and Rao (2003) in their study in Mumbai, India.

categorized the access time of up to 12.0 minutes as a small trip length. By using 12 minutes as an indicator for smaller trip length in Klang Valley, it was discovered that the frequency distribution of all the access modes was decreased within 10-15 minutes of access time. It was also found that walking and drop-off are preferable if access time is within 5.0 minutes. As access time increase until up to 10.0 minutes, walking and drop-off mode options decreased. The use of taxi, park and ride and bus have also showed a similar trend with respect to access time increment. As access time increased until up to 10 minutes, taxi, park and ride and mode options increased. Interestingly, the bus mode option exhibited inconsistent trend with access time increment. The possible explanation was because frequent rail users are coming from different areas in Klang Valley and stay closer or further away from rail station. The similarity in the access modes distribution (bus, park and ride, taxi) except for drop-off and walking within a range of 5-15 minutes and 25-35 minutes was probably due to the availability of parking facilities at the rail station, affordable public transport fare and easy access to taxi or bus from home to rail station.

4.3.4.4 Access Cost of Frequent Rail Users

In this study, the access cost is referred to the amount of cost spent by frequent rail users to reach rail station from home. The frequent rail users spent RM 0 if they are walking and spent between RM 1.00 to RM 6.40 if they are using different access mode from home to rail station. The relationship between access mode share versus access cost is shown in Figure 4.3.

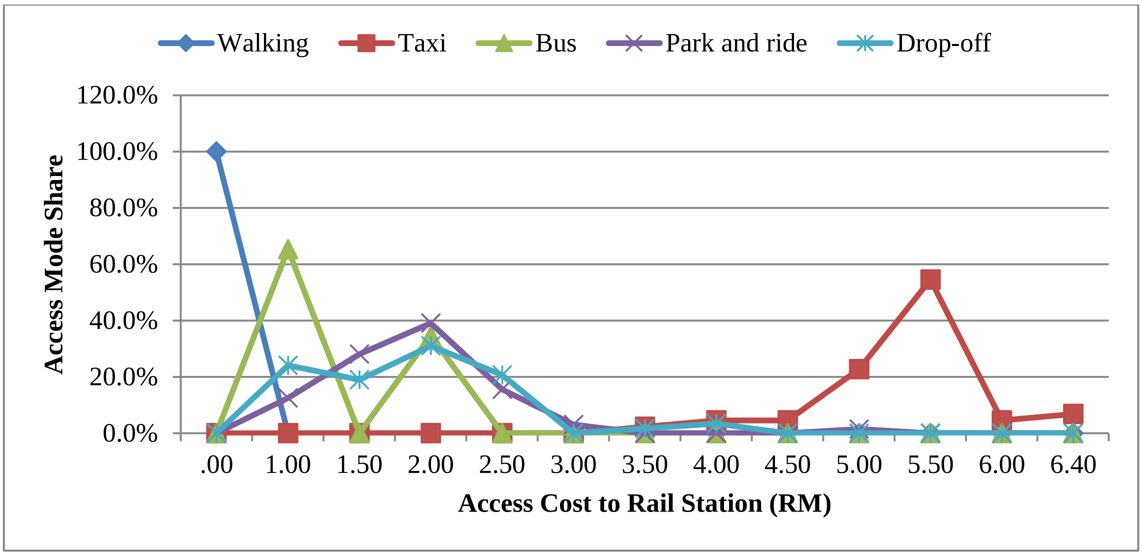

Figure 4.4: Relationship between Access Mode Share and Access Cost to Rail Transit Station in Klang Valley

There is no access cost recorded for the case of walking mode. In general, the trend showed decreasing use of a vehicle with an increase in access cost. This is more pronounced in the case of bus, park and ride and drop-off access mode users. In the case of buses, more than 60.0% of frequent rail users are accessing the transit station from distances equivalent to the minimum bus fare of RM1.00. In the case of park and ride and drop-off users, majority of them are accessing rail stations for a cost equal to or less than RM2.00. The longer tail of distribution is because of taxi use. The taxi users spent 3.5 times more than bus users on their access cost. With the inclusion of walking as access mode, the distribution showed that more than 33.8% of frequent rail users do not incurred a monetary cost for their access trip.

4.3.4.5 Travel Distance of Frequent Rail Users

The relationship between the overall travel distance versus access mode share is depicted in Figure 4.5. The overall travel distance is distributed from 0-10 km until up to 40 km. The access mode share for each travel distance category was compared to determine whether the use of motorized and non-motorized access mode will influence the overall travel distance of frequent rail users.

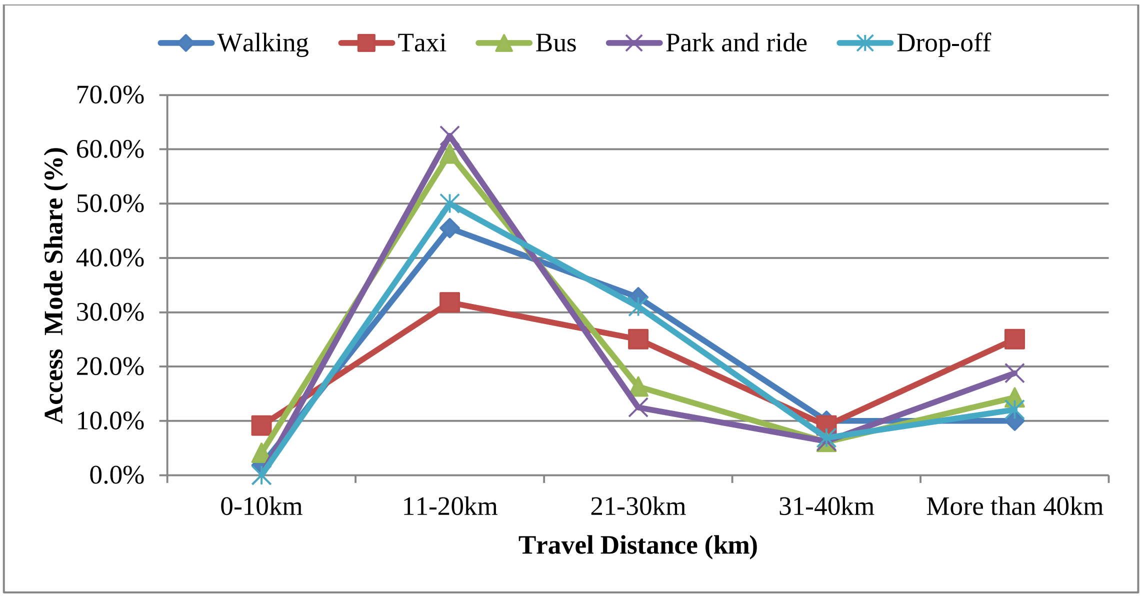

Figure 4.5: Relationship between Access Mode Share and Travel Distance

As depicted in Figure 4.5, there was an obvious inclination towards particular access mode over one another. It can be seen that frequent rail users preferred motorized transport for travel distance of more than 40 km. Additionally, park and ride, and bus modes were dominant access mode for shorter travel distance, which is within 0-20 km. It was also discovered that frequent rail users who walked to rail station travelled in shorter travel distance as compared to other access modes. Other than that, walking and drop-off were dominant access modes for those who travelled in intermediate travel distance (21-40 km). Nevertheless, it was interesting to note that the inclination of using bus for longer access distance (> 2000m) was not in line with overall travel distance trend from home to final destination and the return journey. It was also found that taxi was the dominant access mode for longer travel distance (> 40km).

4.3.4.6 Travel Time of Frequent Rail Users

The relationship between travel time and access mode share is depicted in Figure 4.6. The overall travel time taken by frequent rail users from the first and last mile trip was varied from 11-20 minutes until up to 100 minutes. The access mode share for each travel time category was compared to determine whether the use of motorized and non-motorized access mode will influence the overall travel time of frequent rail users.

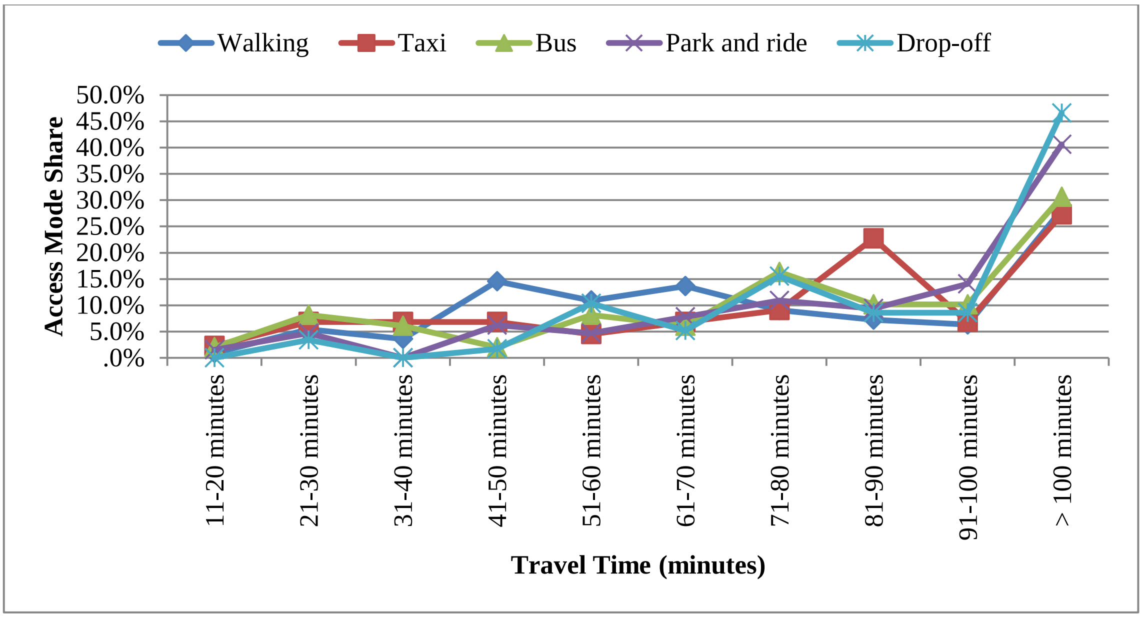

Figure 4.6: Relationship between Access Mode Share and Travel Time

It was observed that majority of frequent rail users travelled more than 100 minutes per day regardless the type of their access mode. The park and ride, and drop-off were the major access modes, which were used for travel time of more than 100 minutes. A possible explanation for this might be because of the traffic congestion at rail transit station. Another possible explanation was frequent rail users were taking the time to park their vehicle because of insufficient parking facilities at the certain rail station. However, through observation, there was obvious indication that frequent rail users struggled in terms of travel time because majority of them travelled for a longer period despite access mode type that they used to reach rail station.

4.3.4.7 Travel Cost of Frequent Rail Users

The relationship between the daily travel cost and access mode share is depicted in Figure 4.7. The daily travel cost spent by frequent rail users is varied from RM1.90 to RM19.90. The access mode share for each travel cost category was compared to determine whether the use of motorized and non-motorized access mode will influence the overall travel expenditure of frequent rail users.

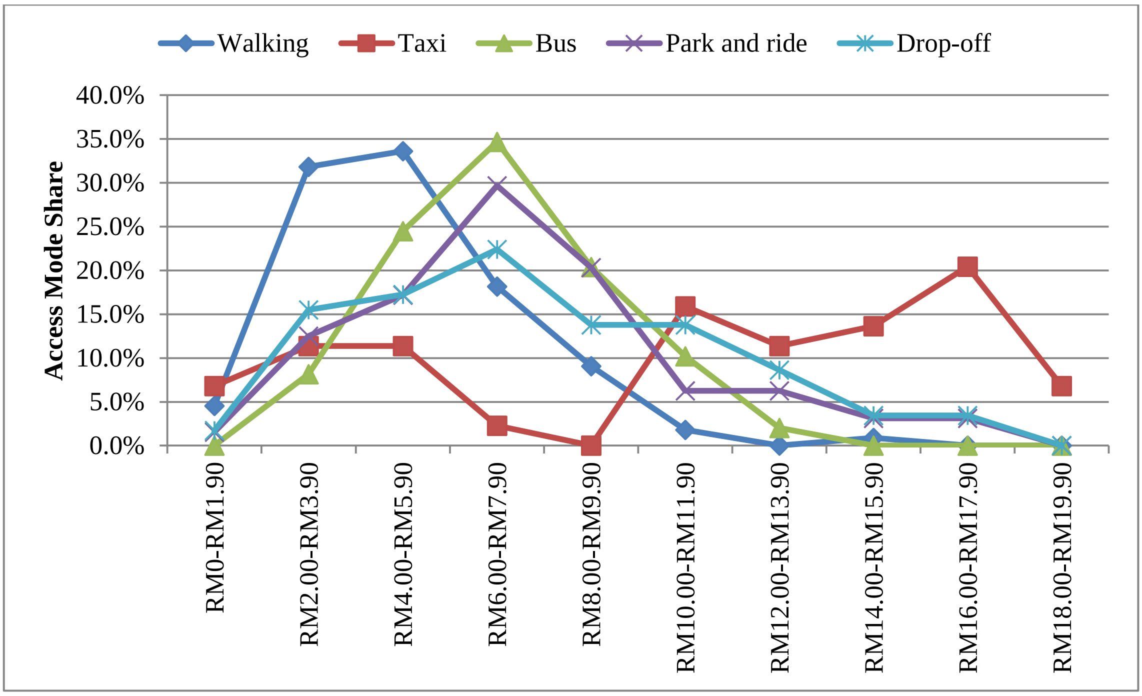

Figure 4.7: Relationship between Access Mode Share and Travel Cost

As depicted in Figure 4.7, it was expected that frequent rail users who used taxi to reach rail station spent the highest travel cost as compared to other access modes. A possible explanation for this might be because of high taxi rates in Klang Valley area.

The taxi rates are RM 3.00 (Budget Taxi), RM 4.00 (1 Malaysia Taxi) and RM 6.00 (Executive Taxi), for the first km or the first 3 minutes (Land Public Transport Commission, 2015). It was also estimated that the taxi fare for 5 km distance is in the range of RM 8.00 to RM 14.00 which is depending on traffic situation (Land Public Transport Commission, 2015). In this study, 66.7% of frequent rail users who used taxi to reach rail station from home travelled more than 2 km. It was seen that those who walked to rail station spent the lowest travel cost compared to others. Apparently, due to the fact overall travel cost was highly influenced by the access cost.

Based on the finding, it was crucial to investigate the pattern and key factor of access attributes in order to enhance the accessibility to station and service quality of the rail transit services especially in Klang Valley area and other related places. It was previously proven that there were increments in public transport ridership when accessibility was improved as in the case of Melbourne, Australia. The low accessibility to public transport services urged high car usage among low-income households. By extending the public transport (PT) routes to the outer, lower income suburbs and by improving the accessibility, the public transport ridership will be increased. Also, the good access to PT will lead them into selling their cars because PT service has fulfilled their mobility requirement thus less reliant on rides.

Nevertheless, it was noted that the properties located closer to stations exhibited higher rental price as observed in Bogota, Colombia (Rodriquez & Targa, 2004; Redman, et al., 2013). This is because of commuters' valuation of time and speed to access the PT service. This indicated that commuters valued access time as an important key in PT services. However, it was highlighted that minimum satisfaction on public transport service quality must be provided in order to ensure ridership increment (Loader & Stanley, 2009).

4.3.5 Trip Origin and Destination

Previously, it was stated that 325 respondents out of 559 were frequent rail transit users. However, there were only 245 respondents (frequent rail users) completed the questions on their trip origin and destination. The trip origin and destination of frequent and private transport users were categorized according to the municipal council region. The distribution of trip origin and destination for frequent rail transit users is shown in Table 4.4 and Figure 4.8.

Table 4.4: Trip Origin and Trip Destination of Frequent Rail Users

Trip origin			Trip destination		
Municipal Council	**Frequency**	**Percent (%)**	**Municipal Council**	**Frequency**	**Percent (%)**
Ampang Jaya	22	9.0	Ampang Jaya	9	3.7
Hulu Selangor	1	0.4	Hulu Selangor	0	0.0
Kajang	9	3.7	Kajang	6	2.4
Klang	3	1.2	Klang	1	0.4
Kuala Lumpur	137	55.9	Kuala Lumpur	188	76.7
Kuala Selangor	1	0.4	Kuala Selangor	0	0.0
Petaling Jaya	21	8.6	Petaling Jaya	20	8.2
Refused	0	0.0	Refused	9	3.7
Sabak Bernam	1	0.4	Sabak Bernam	0	0.0
Selayang	24	9.8	Selayang	5	2.0
Sepang	3	1.2	Sepang	0	0.0
Seremban	1	0.4	Seremban	0	0.0
Shah Alam	12	4.9	Shah Alam	4	1.6
Subang Jaya	10	4.1	Subang Jaya	3	1.2
Total	245	100.0	Total	245	100.0

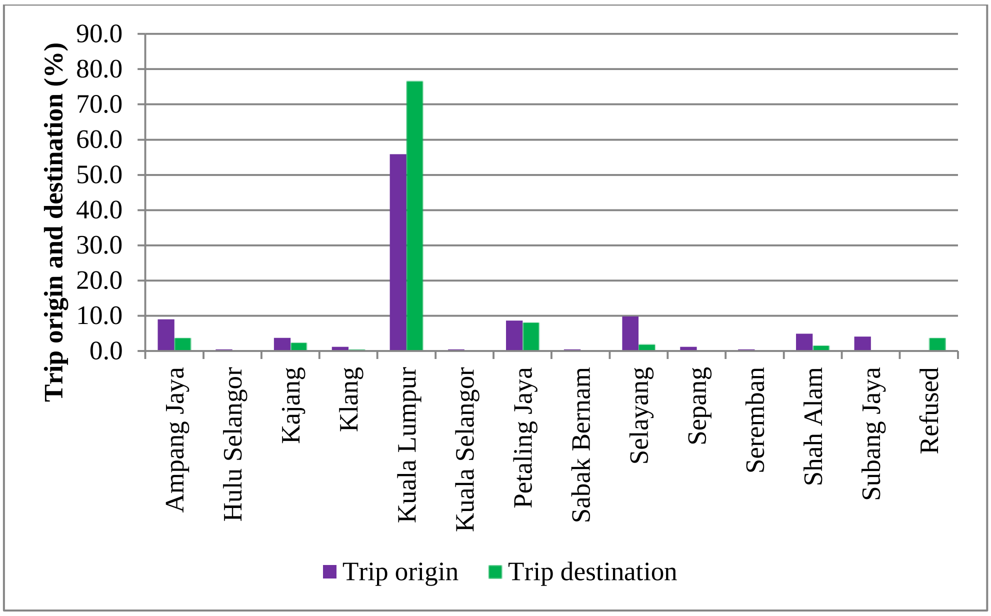

Figure 4.8: Trip Origin and Destination Distribution of Frequent Rail Users

The trip origins and destinations of frequent rail transit users were arranged alphabetically starting from Ampang Jaya to Subang Jaya municipal council region. From Table 4.4, most trips started from Kuala Lumpur (55.5%) and distributed almost equally from Selayang (9.8%), Ampang Jaya (9.0%) and Petaling Jaya (8.6%). Similarly, more than two third of the trips ended at Kuala Lumpur area (76.7%) and only 23.3% of the trips ended at other places, namely, Petaling Jaya, Ampang Jaya, Kajang, Selayang, Shah Alam, Subang Jaya and Klang. It was also observed that 3.7% of the frequent rail users refused to provide information on their trip destination. In addition to that, it was discovered that 33.9% of the frequent rail users, which stay (trip origin) and work (trip destination) in Kuala Lumpur conurbation areas travelled within 11-30 km for their daily journey. The distribution of trip origin and destination for private transport users is shown in Table 4.5 and Figure 4.9.

Table 4.5: Trip Origin and Destination Distribution of Private Transport Users

Trip origin			Trip destination		
Municipal Council	**Frequency**	**Percent (%)**	**Municipal Council**	**Frequency**	**Percent (%)**
Ampang Jaya	21	9.0	Ampang Jaya	3	1.3
Hulu Selangor	0	0.0	Hulu Selangor	0	0.0
Kajang	24.0	10.3	Kajang	8	3.4
Klang	3	1.3	Klang	0	0.0
Kuala Lumpur	77	32.9	Kuala Lumpur	148	63.2
Kuala Selangor	0	0.0	Kuala Selangor	0	0.0
Petaling Jaya	29	12.4	Petaling Jaya	19	8.1
Refused	24	10.3	Refused	31	13.2
Sabak Bernam	0	0.0	Sabak Bernam	0	0.0
Selayang	24	10.3	Selayang	8	3.4
Sepang	0	0.0	Sepang	0	0.0
Seremban	6	2.6	Seremban	0	0.0
Shah Alam	13	5.6	Shah Alam	9	3.8
Subang Jaya	13	5.6	Subang Jaya	8	3.4
Total	234	100.0	Total	234	100.0

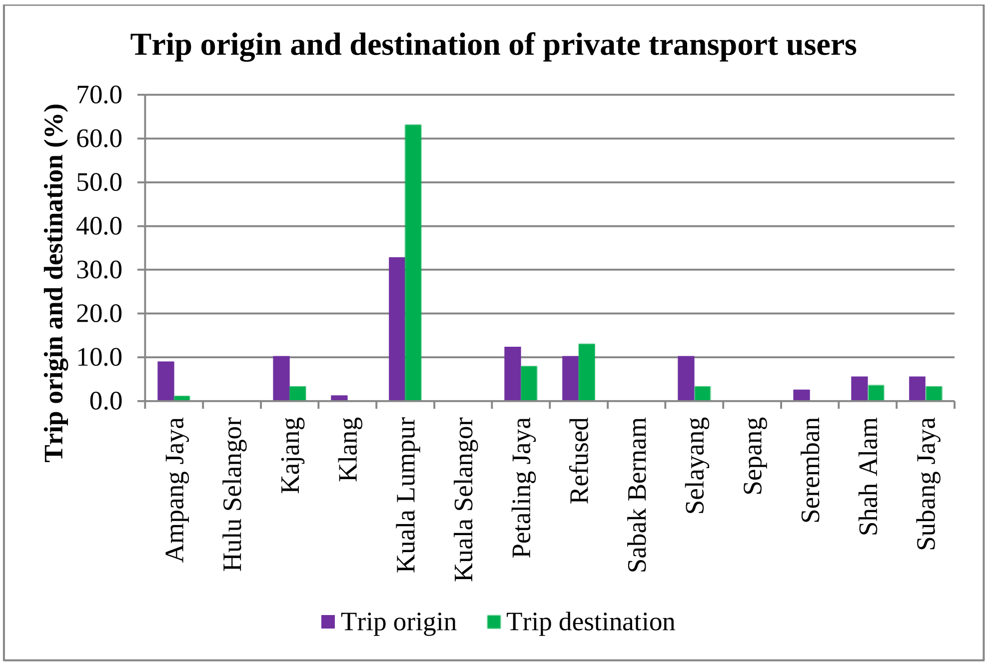

Figure 4.9: Trip Origin and Destination Distribution of Private Transport Users

The trip origins and destinations of private transport users were arranged alphabetically starting from Ampang Jaya to Subang Jaya municipal area. As presented in Table 4.5 and Figure 4.9, most trips started from Kuala Lumpur (32.9%), followed by Petaling Jaya (12.4%) and then distributed equally from Kajang (10.3%) and Selayang (10.3%). It was also found that 10.3% of the private transport users refused to provide information about their trips origin. In addition, there are no private transport users coming from Hulu Selangor, Kuala Selangor, Sabak Bernam and Sepang municipal areas. As for trip destination information, more than half of the trips ended at Kuala Lumpur area (63.2%) and only 36.8% of the trips ended at other places, namely, Petaling Jaya, Shah Alam, Subang Jaya, Selayang, Kajang and Ampang Jaya. It was also observed that 13.2% of the private users refused to provide information on their trip destination. In addition to that, it was also discovered that 19.2% of the private transport users, which stay (trip origin) and work (trip destination) in Kuala Lumpur conurbation areas travelled within 0-30 km for their daily journey.

4.4 Reason of Using Rail Transit System

The frequent rail users were asked to rate the list of motivational factors that make them travel daily with rail transit. The twelve factors were fastness, reliability, security, affordability, comfortability, accessibility, unavailability of vehicle, closer access distance, closer egress distance, availability of park and ride facilities, less stressful and environmental awareness. The frequent rail users were asked to rate the reasons with a score range from 1, “strongly disagree” to 5, “strongly agree”. The internal consistency of the twelve factors indicated a scale of high reliability (Hinton, 2004), Cronbach’s alpha, $\alpha_{\text{factoruse\_frequent}} = 0.84$. The analysis of factors versus the percentage of agreement level and mean was presented in Figure 4.10.

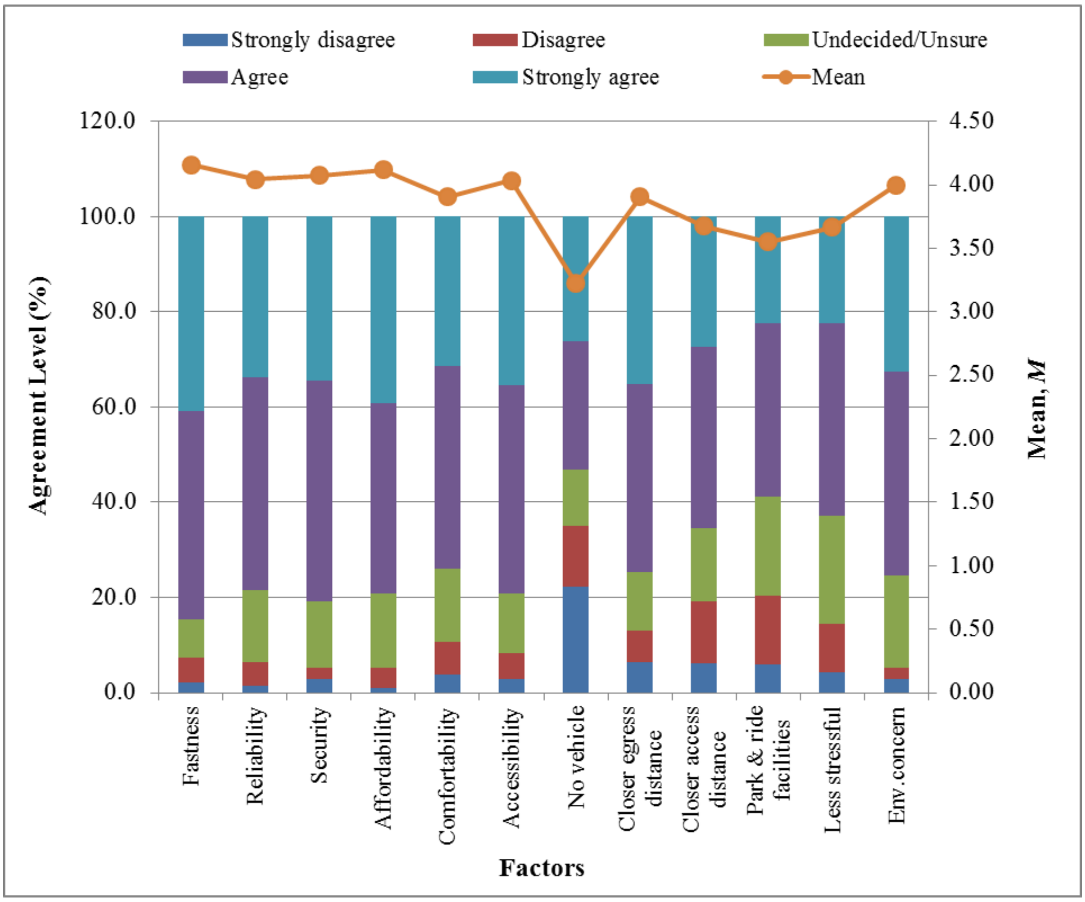

Figure 4.10: Distribution of Mean and Agreement Level on Factors that Influence Frequent Users Travel Daily with Rail Transit

In Figure 4.10, it was indicated that frequent rail users have positive perception (Median, *Mdn* = 4, ‘Agree’ and Mode = 4, ‘Agree’) towards listed motivational factors which influenced their decision to use rail as daily travel mode. The Median, *Mdn* result showed that, a) half of the perception or 50% of the frequent rail users are placed in scale 1 until scale 4 and b) half or 50% of the frequent rail users are placed between scale 4 and 5. However, it was also found that frequent rail users were ‘strongly disagree’ and ‘disagree’ with unavailability of vehicle (35.1%), availability of park and ride facilities (20.3%) and close to home (19.1%) as the factors that motivated them to use rail transit. This is probably because more than one quarter of the frequent users are not the ‘captive’ rider and may use cars for their journey but they preferred to travel by rail. About 33.8% of the frequent rail users are walking to rail station and it was found to be the dominating access mode for distance less than 1000 meters. It was also found that majority (22.8%) of frequent rail users were undecided or unsure whether travelling by rail will be less stressful as compared to other travel modes. Nevertheless, it was interesting to discover that 75.4% of frequent rail users agreed that they travel by rail because of environmental awareness on sustainable transport. It was also found that 59.1% of the frequent users with sustainable transport awareness have at least one vehicle per household, but they still choose to travel by rail transit. In other words, the vehicle availability does not mean that rail would not be considered as a main daily travel mode.

There were four factors that have achieved approximately 80.0% of 'strongly agree and agree' rate. The four factors were fastness (84.6%), security (80.9%), affordability (79.1%) and accessibility (79.1%). This finding was in line with Wibowo (2007), which also found that the main reason of using Bangkok Mass Transit System (BTS) and Metropolitan Rapid Transit (MRT) is because the system is faster. Interestingly, the frequent rail users proximity closer to the workplace and closer to home were ranked as 7^{th} and 9^{th} reasons that make them using rail transit. In this study, it was discovered that there are 39.1% of frequent rail users that travelled more than 2 km to reach rail station from home. This finding indicated that frequent rail users were dissatisfied with their current access distance. Thus, it is important to investigate on their willingness to travel by rail consistently if access distance, access cost and access time is about to be increased. This is aligned with the basic concept of transit accessibility which is the good transit system is not sufficient to attract travellers unless there are many relative advantages that can be gained by using mass transit (Wibowo, 2007).

In addition, the unavailability of the vehicle (53.2%) is the least agreeable factor that influenced frequent users to travel by rail transit daily. This is probably because all of the frequent rail users have either their own's vehicle or their household vehicles as an alternative mode. Contrary to expectations, it was found that 33.8% of frequent rail users walking to reach rail station from home although they can use their vehicles as an access mode to rail station. In addition, only 19.7% of the frequent rail users use their vehicle as an access mode to the station. The study by Givoni and Rietveld (2007) and Marten (2004) found that the availability of cars does not have a strong effect on the choice of access mode to the station and availability of cars does not necessarily mean the railway is not the preferred choice of mode to reach the workplace.

Nevertheless, the mean, *M*, value for each factor was also plotted in Figure 4.10. In line with the previous finding and discussion, majority of frequent rail users agreed that fastness was the highest factors (4.16) that make them travel by rail. In the same way, unavailability of the vehicle was the least agreeable factor (3.22) that make them travel by rail. However, finding from Steg, (2003) perceived traffic safety factor more positively as compared to other attaractiveness factors of public transport. In this study, safety was also rated as the second most agreeable factors, which make commuters travel with rail transit.

4.5 Reasons of Using Private Transport

The private transport users who have experiences travelling by rail transit were asked to rate the list of factors that make them travel daily with private transport as compared to rail transit. In this study, 13 factors were considered as the influential reasons that make them travelled by private transport. The factors are, the (1) rail station is far from home, (2) far from workplace, (3) higher cost when travel by rail transit, (4)longer travel time when using rail, (5) desirable routes outside rail coverage, (6) the rail station is not accessible, (7) more convenience and comfort using private transport, (8) the rail service is not reliable, (9) needs a vehicle for working purposes, (10) flexibility, (11) availability of vehicles to use, (12) more transfer when using rail and (13) feeling safe when use owns' transport. The private transport users were asked to rate the reasons with a score range from 1 "strongly disagree" to 5 "strongly agree". The internal consistency of the variable indicated a scale of high reliability (Hinton, 2004), Cronbach's alpha, $\alpha_{factoruse\_private}$ = 0.84. The analysis of factors versus the percentages of agreement level and mean was presented in Figure 4.11.

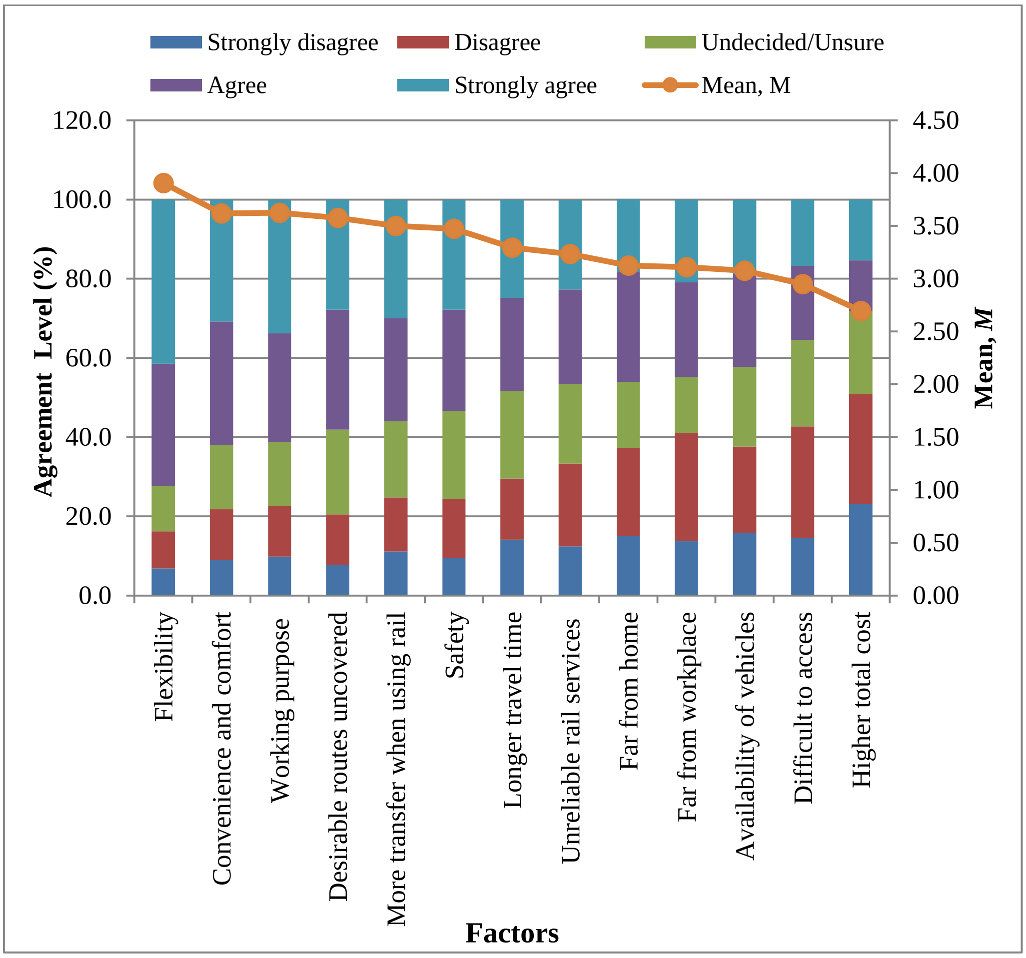

Figure 4.11: Distribution of Mean and Agreement Level on Factors that Influence The Use of Private Transport

In Figure 4.11, the median values of factors that influence private transport users, Median, *Mdn* = 3, 'Undecided/Unsure'. This finding showed that a) half of the perception or 50% of the private transport users are placed in scale 1 until scale 3 and b) half or 50% of the private transport users are placed between scale 3 and 5. However, based on the mean value for all the factors, Mean, $M = 3.32$, it can be determined that private transport users have slightly positive perception towards listed motivational factors which influenced their decision to use private transport as daily travel mode. However, it was also found that majority of frequent rail users were 'strongly disagree' and 'disagree' that total cost of using rail transit is higher than private transport total cost (50.9%), difficult to access rail station (42.7%) and far from workplace (41.1%) as the factors that influenced private transport users to use their vehicles as daily travel mode. This finding possibly indicated that rail transit station is accessible from their home (origin) and workplace (final destination). In addition, the private transport users probably aware that their current travel cost using private transport was higher compared to travel cost when they are using rail transit. This finding was supported by Hagman (2003), which stated that travel cost is the disadvantage factor while using private transport for journey. This is probably because drivers only equate their travel cost with fuel costs and unaware of other costs, which were related to their journey (Gardner & Abraham, 2007). On the other hand, research by Steg (2003) on Dutch population showed similar judgement on travel cost when using public and private transport. However, Jensen (1999) stated that effective strategies with related to private transport policies should be implemented because in general car users were unlikely to change their travel mode to public transport even though public transport coverage was expanded and the public transport system facilities is improved.

Furthermore, the bars in Figure 4.11 were also indicated the rate of 'strongly agree and agree' on the factors that make respondents using private transport. Apparently, six factors achieved more than 50% of 'strongly agree and agree' rate. The factors were flexibility (72.3%), convenience and comfort (62.0%), working purpose (61.2%), route outside rail coverage (58.1%), more transfers when using rail (56.0%) and safety factor (53.4%). With respect to safety factor, frequent rail users were rated travelling by rail is much safer as compared to travelling by private transport with 27.5% difference. Research by Steg (2003) also stated that travelling by public transport is perceived to be safer than driving a car. Interestingly, 72.3% of private transport users perceived flexibility in planning their journey as the most agreeable factors of using their own transport. Study by Beirao and Cabral (2007) and Steg (2003) described the use of own's car as a freedom, flexibility and convenient to overcome issues associated with the time taken when using public transport. Therefore, considering all the factors, correlation analysis using the Pearson correlation method is carried out to examine relationship that might exist between flexible, convenient and travel time factor. The results showed that there was a positive and medium or average relationship (correlation coefficient size, r = 0.51 to 0.70 or -0.51 to -0.70) (Chua, 2013) between travel time and flexible factor (r = 0.505), between travel time and convenient factor (r =0.545) and between convenient and flexible factor (r =0.654). These relationship was significant at the 0.05 level (p = 0.0001). It can be concluded that convenient and flexibility factor of private transport was significantly in agreement with the notation that using rail transit requires longer travel time as compared to private transport.

4.6 Current Satisfaction on Rail Transit System

Measurement on the current satisfaction of urban rail transit system among frequent rail users was presented in Figure 4.12. This evaluation was considered in order to investigate satisfaction level of current rail transit system based on frequent rail transit and private transport users' perception and experiences. The six attributes of current rail transit performances, which have been evaluated, were (1) rail transit frequency, (2) rail fare, (3) facilities at rail station and inside the rail, (4) safety at rail station and inside the rail, (5) comfortability and (6) management of complaint. The current rail satisfaction was measured with a score range from 1 "Very poor" to 5 "Very good". The internal consistency of the variables indicated a scale of high reliability (Hinton, 2004; Chua, 2013), Cronbach's alpha, α = 0.841 for frequent rail users and, Cronbach's alpha = 0.853 for private transport users.

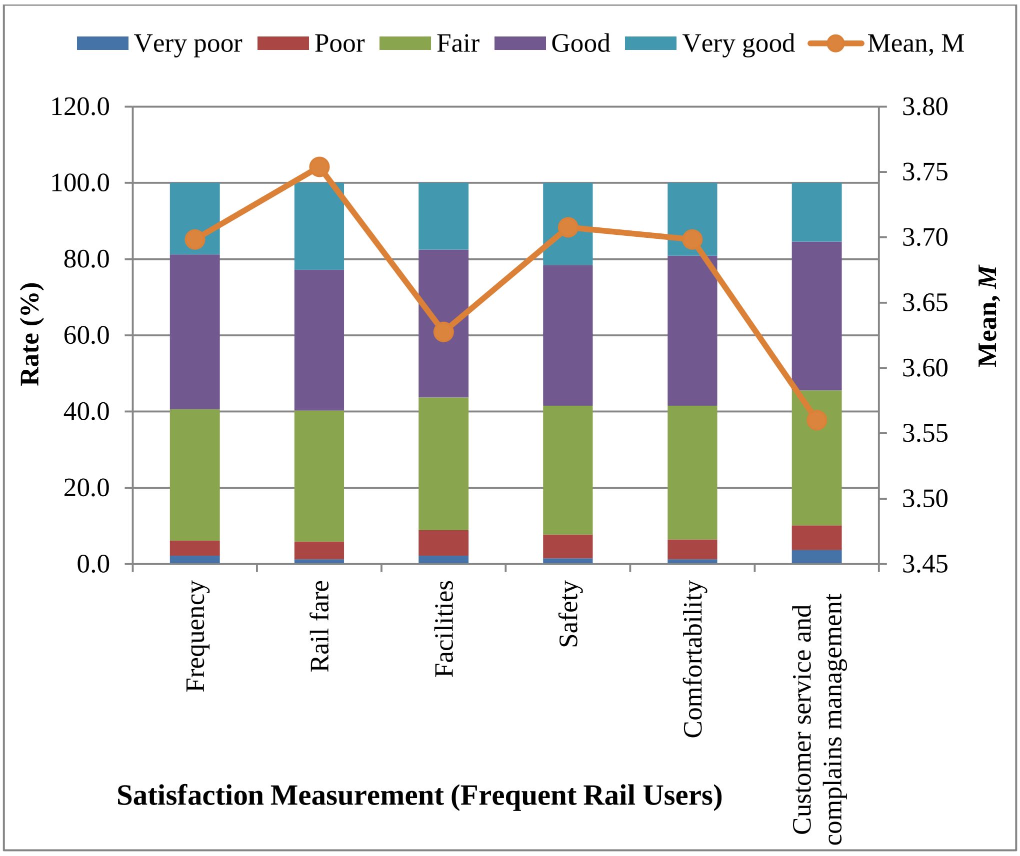

Figure 4.12: Current Satisfaction of Rail Transit System Based on Frequent Rail Users Evaluation

As depicted in Figure 4.12, the analysis of the data revealed that the frequent rail transit users ranked ticket fare as the highest (59.7%) in terms of 'Very good' and 'Good' as compared to other current satisfaction measurement. The customer service and management of complains was ranked as the lowest performance (10.2%). In overall, the mean value for all the performance measurement was 3.67. However, it was found that more complaints were highlighted on the service reliability and operational system of the rail transit (Kumar, 2015; Zulzaha, 2016). The current satisfaction results rated by frequent rail transit users will be used later in Structural Equation Modelling Analysis.

Measurement on the current satisfaction of urban rail transit system among private transport users was presented in Figure 4.13 below.

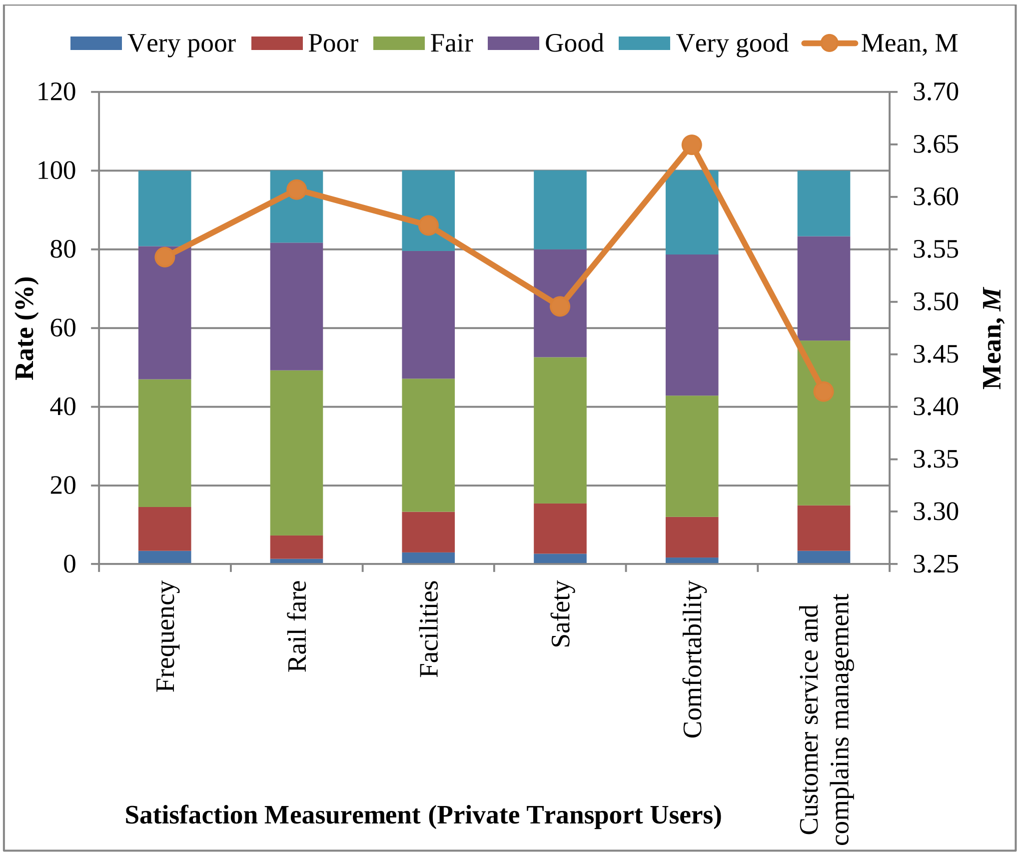

Figure 4.13: Current Satisfaction of Rail Transit System Based on Private Transport Users Evaluation

Interestingly, private transport users ranked the comfortability in the rail and at the station as the highest (57.3%) in terms of 'Very good' and 'Good' as compared to other attributes. It was discovered that safety at station and inside rail transit was ranked as the lowest satisfaction (15.4%) according to private transport users.

Independent sample t-test was carried out to determine whether the mean values of current satisfaction between frequent rail users differ significantly from the mean values of private transport users. From Independent sample t-test, it was discovered that only rail safety satisfaction indicated statistically significant different at $p < 0.05$ as compared to other satisfaction measurement. The analysis on rail safety satisfaction yielded a *t*-value of 2.545 which was significant at 0.05 level (p = 0.011). The mean difference value of 0.212 showed that, the frequent rail users are more satisfied on rail safety as compared to private transport users. This implied that a further look into this difference in terms of a whole rail performance is imperative especially in order to give better perception in encouraging voluntary initiative among private transport users to use rail transit as their daily travel mode.

4.7 Important Factors Influencing Rail Transit Use

Throughout this study, the frequent rail and private transport users were asked to rate the important rail transit system traits, which are of importance to them when travel with rail transit system. There were seven rail transit system traits that were considered. The rail transit system traits, which have been evaluated, were (1) access to rail transit, (2) in-vehicle time, (3) rail fare, (4) safety at station and inside rail, (5) service reliability, (6) comfort and cleanliness and (7) rail integration between rail transit systems. These factors were measured with a score range from 1 “Not important” to 5 “Very impotant”. The internal consistency of the variables indicated a scale of high reliability (Hinton, 2004), Cronbach’s alpha for frequent rail users, $\alpha = 0.873$ and Cronbach’s alpha for private transport users, $\alpha = 0.897$. The findings on important level of rail transit system attributes were depicted in Figure 4.14 and Figure 4.15 below.

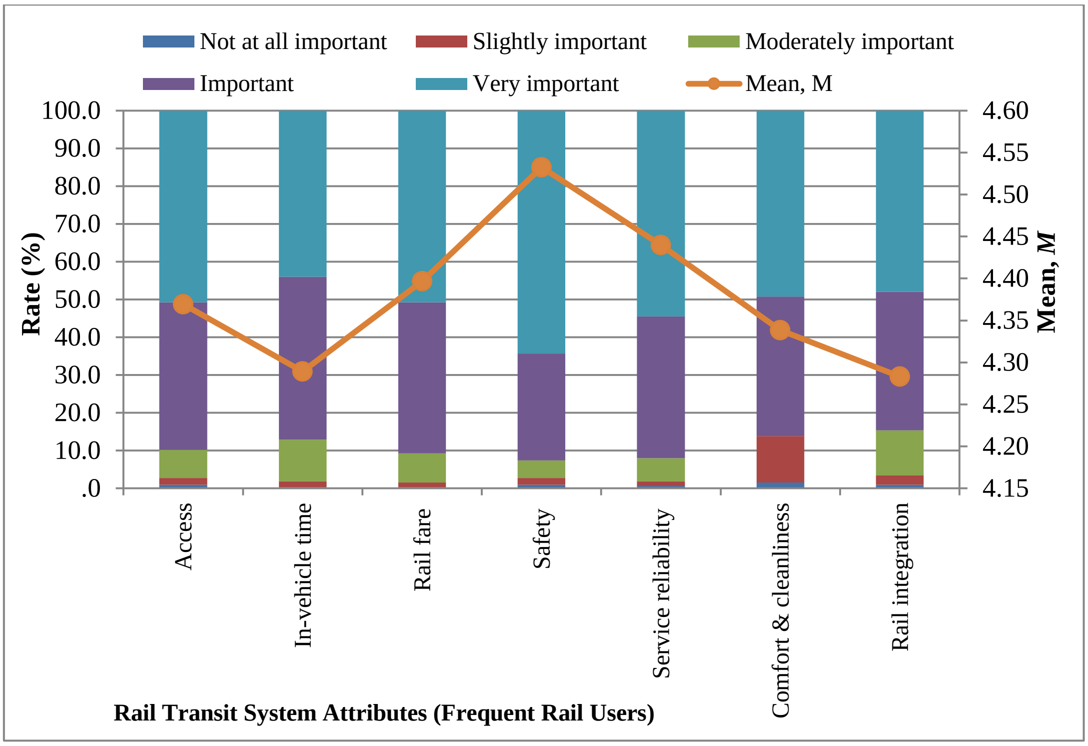

Figure 4.14: Rail Transit System Traits Rated by Frequent Rail Users

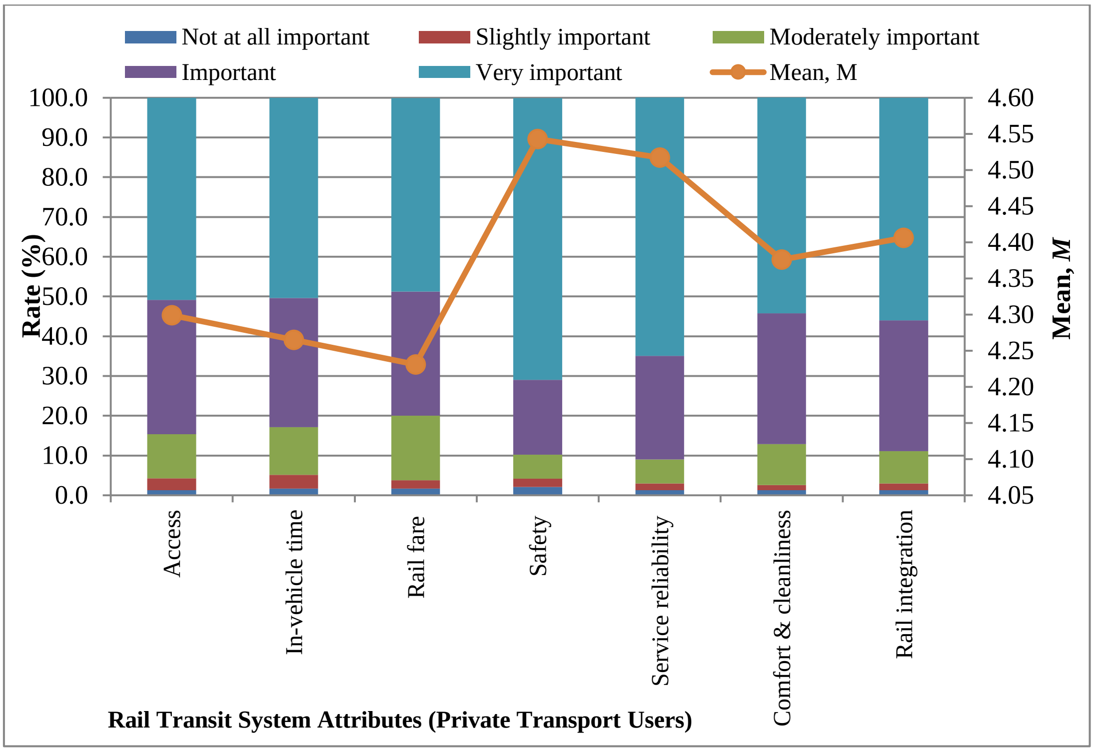

Figure 4.15: Rail Transit System Traits Rated by Private Transport Users

Based on the overall mean values, it was interesting to discover that the important level of rail transit system traits were rated similar (4.38) either by frequent rail users or by private transport users. It was unexpected because frequent rail users should be reflected more with rail transit system attributes which are crucial to them since they travelled more regularly using rail transit as compared to private transport users. The private transport users feedback was important because they have had experiences travelling by rail for their journey. The findings on important level of rail transit system traits rated by frequent rail transit users will be used later in Structural Equation Modelling Analysis.

Apparently, there were three factors, which were rated more than 90.0% of ‘Very important’ and ‘Important’ according to frequent rail users. These factors were safety at station and inside rail (92.6%), service reliability (92.0%) and rail fare (90.8%). Whereas, private transport users were reflected more on service reliability (91.1%) as the most important factors which will influence them to use rail as daily travel mode. This finding could be liaised with the rail frequency performance which showed that 47.0% of private transport users and 40.6% of frequent rail users rated rail frequency as fair and below. This finding provided some support on lower share of rail frequency among private transport users. About 22.2% of private transport users seldomly travelled with rail transit and 77.8% of them using rail at least once a month for their trip. A possible explanation is private transport users might be using rail transit in the weekend when they are not in the rush and use rail for recreational activities or social purposes. In addition to that, the private transport users also rated safety and rail integration as the 2nd and 3rd rail transit system attributes which are of importance to them.

Independent sample t-test was carried out to determine whether the mean values of important level on rail transit system traits between frequent rail users differ significantly from the mean values of private transport users. The analysis on important level of rail fare yielded a t-value of 2.413 which was significant at the 0.05 level ($p = 0.016$). There is a difference between frequent rail users and private transport users in viewing the important level of rail fare. The mean difference value of 0.166 shows that in the population from which the sample is drawn, the frequent rail users highlighted rail fare more importantly as compared to private transport users. This implies that a further look into this difference is imperative especially in providing better rail services by considering feedback on what are the most concerned factors or attributes that will influence travellers when using rail transit system.

4.8 Modelling Mode Choice Behaviour of Frequent Rail Users and Private Transport User

In this study, out of 559 questionnaire responses, 325 responses were from frequent rail users. For private transport users, 234 responses were obtained. Analysis of the stated preference data included a comprehensive description of the statistical tests used to evaluate the appropriateness of the model parameters and the overall goodness-of-fit of the model. The results are presented in two parts. In Part 1, the series of Binary Logit models is presented for rail versus private transport under different hypothetical travel scenarios. The utility of the two modes were compared to comprehend what will be a trade-off for frequent rail users if they shift to private transport. The probabilities of frequent rail users to (i) travel consistently by rail transit and (ii) shifting to private transport mode were also examined. In Part 2, the series of Binary Logit models is presented for private transport versus rail transit under hypothetical travel scenarios. The utility of the two modes were also compared to comprehend what will be a trade-off for private transport if they shift to rail transit. The probabilities of private transport users to (i) travel consistently by rail transit and (ii) shifting to private transport mode under different hypothetical travel scenarios were presented and discussed.

During the analysis process, an interesting issue that has been discovered is the inertia effect. In particular, inertia effect is the tendency to stick with the past choice even another alternative become more appealing or attracting (Swait et al., 2004; Cantillo et al., 2007; Yanez et al., 2009; Cherchi & Manca, 2011; Cherchi et al., 2013; Meloni et al., 2013). There were many studies that have been done and most of them indicated that past behaviour is a strong influence or predictor of future behaviour. As this due to the fact that individuals will tend repeat the same choices if there are no external changes occurring (Meloni, 2013).

4.8.1 Binomial Logistic Regression Analysis

The logistic regression analysis is a linear probability method of predicting a category dependent variable using a set of predictor variables in numerical scale or a combination of numerical and categorical scale variables (Abd Rahim Md Nor, 2009). In this study, the relationship of travel mode choice preference and socio-economic characteristics along with travel attributes under different hypothetical travel scenarios was analysed using Binomial Logistic Regression. The Binomial Logistic Regression is a logistic regression models, which predicts the probability that an observation falls into one of two categories of a dichotomous dependent variable based on one or more independent variables that can be either continuous or categorical (Abd Rahim Md Nor, 2009). The socio- demographic characteristics and travel attributes are independent variables for this study. The dependent variable are travel mode choice, namely rail transit and private transport mode. The influences of socio-demographic characteristics and travel attributes, namely, gender, access mode, age, job status, monthly income, availability of license, availability of vehicle, educational level, travel purpose and number of trip were included in the models. The stated preference travel scenarios for each access cost increment/decrement, access time increment/decrement, access distance increment/decrement, travel cost increment/decrement, travel time increment/decrement and travel distance increment/decrement, and travel frequency decrement/increment was included in the models and analysed separately. For frequent rail users, their current travel mode, which was rail transit, was selected as a reference category. While, for private transport users, their current travel mode choice, namely private transport, was selected as a reference category.

Six hypotheses were derived for frequent rail users and seven hypotheses were derived for private transport users. The hypotheses of frequent rail users analysis are as follows:

(1) Significant relationship is assumed between socio-demographic characteristics and access cost increment with probability of shifting to private transport mode.

(2) Significant relationship is assumed between socio-demographic characteristics and access time increment with probability of shifting to private transport mode.

(3) Significant relationship is assumed between socio-demographic characteristics and access distance increment with probability of shifting to private transport mode.

(4) Significant relationship is assumed between socio-demographic characteristics and travel cost increment with probability of shifting to private transport mode.

(5) Significant relationship is assumed between socio-demographic characteristics and travel time increment with probability of shifting to private transport mode.

(6) Significant relationship is assumed between socio-demographic characteristics and rail frequency decrement with probability of shifting to private transport mode.

The hypotheses of private transport users analysis are as follows:

(1) Significant relationship is assumed between socio-demographic characteristics and fuel price increment with probability of shifting to rail transit mode.

(2) Significant relationship is assumed between socio-demographic characteristics and travel cost increment with probability of shifting to rail transit mode.

(3) Significant relationship is assumed between socio-demographic characteristics and travel time increment with probability of shifting to rail transit mode.

(4) Significant relationship is assumed between socio-demographic characteristics and access cost decrement with probability of shifting to rail transit mode.

(5) Significant relationship is assumed between socio-demographic characteristics and access time decrement with probability of shifting to rail transit mode.

(6) Significant relationship is assumed between socio-demographic characteristics and access distance decrement with probability of shifting to rail transit mode.

(7) Significant relationship is assumed between socio-demographic characteristics and rail frequency increment with probability of shifting to rail transit mode.

The dependent variable is MODE CHOICE, which is referred to the travel mode. The socio- demographic variables such as gender (GENDER), age (AGE), occupation (JOB STATUS), income per month (MONTHLY INCOME), license availability (LICENSE), vehicle availability (CAR PER HOUSEHOLD), travel purpose (TRAVEL PURPOSE), number of trips per week (NUMBER OF TRIP) have been used in previous research to explain travel mode choice (Kim et al., 2007; Kmanba, 2008; Wibowo & Chalermpong, 2010; Al-Atawi, 2015). The access mode to reach rail station from home (ACCESS MODE) has been considered as one of the independent variables in order to attain the study objectives. The descriptions for each independent variables and dependent variable are presented in Table 4.6.

Table 4.6: Model Variables

Variable	Value
Dependent Variable	
MODE CHOICE	*For frequent rail users,* 0= Rail transit 1= Private transport *For private transport users,* 0= Private transport 1= Rail transit
Independent Variables (Frequent Rail Users and Private Transport Users)	
GENDER	0=Male 1=Female
AGE	1=18-24 years old 2=25-30 years old 3=31-40 years old 4=41-50 years old 5=51-60 years old 6= > 61 years old
JOB STATUS	1=Pensioner/Housewife/Part-timer 2= Student 3= Blue collar jobs 4= White collar jobs 5= Self-employed / Businessman 6= Management / Executive 7= Professional
MONTHLY INCOME	1= Less or equal to RM1000 2= 1001 - 2000 3= 2001 - 3000 4= 3001 - 4000 5= 4001 - 5000 6 =More or equal to 5001
Independent Variables (Frequent Rail Users and Private Transport Users)	
LICENSE	0= No 1= Yes
AVAILABILITY OF VEHICLE	Continuous data
TRAVEL PURPOSE	0= Work 1= Other purpose
NUMBER OF TRIP	Continuous data
ACCESS MODE	0= Walking 1= Other access modes
Six Case Scenarios of Frequent Rail Users	
ACCESS COST (Exclude Walking)	Increment of current access cost (out-of-pocket) from home to rail station, 1= 10% increment from current access cost 2= 20% increment from current access cost 3= 30% increment from current access cost 4= 40% increment from current access cost 5= 50% increment from current access cost 6= 60% increment from current access cost

‘Table 4.6, continued’

Variable	Value
Six Case Scenarios of Frequent Rail Users	
ACCESS TIME	Increment of access time from home to rail station, 1= 5 minutes increment from current access time 2= 10 minutes increment from current access time 3= 20 minutes increment from current access time 4= 30 minutes increment from current access time 5= 40 minutes increment from current access time
ACCESS DISTANCE	Increment of access distance from home to rail station, 1= 100m increment from current access distance 2= 300m increment from current access distance 3= 500m increment from current access distance 4= 700m increment from current access distance 5= 900m increment from current access distance 6= 1000m increment from current access distance
TRAVEL COST	Increment of total travel cost from home to final destination and for the return journey, 1= 10% increment from current travel cost 2= 20% increment from current travel cost 3= 30% increment from current travel cost 4= 40% increment from current travel cost 5= 50% increment from current travel cost 6= 60% increment from current travel cost
TRAVEL TIME	Increment of total travel time from home to final destination and for the return journey, 1= 5 minutes increment from current travel time 2= 10 minutes increment from current travel time 3= 20 minutes increment from current travel time 4= 30 minutes increment from current travel time 5= 40 minutes increment from current travel time
RAIL FREQUENCY	Decrement of rail frequency per hour, 1= From 8 to 7 times per hour 2= From 8 to 6 times per hour 3= From 8 to 5 times per hour 4= From 8 to 4 times per hour 5= From 8 to 3 times per hour
Seven Case Scenarios of Private Transport Users	
FUEL PRICE	Increment of current fuel price, 1= 10% increment from current fuel price 2= 20% increment from current fuel price 3= 30% increment from current fuel price 4= 40% increment from current fuel price 5= 50% increment from current fuel price 6= 60% increment from current fuel price

‘Table 4.6, continued’

Variable	Value
Seven Case Scenarios of Private Transport Users	
TRAVEL COST	Increment of total travel cost from home to final destination and for the return journey, 1= 10% increment from current travel cost 2= 20% increment from current travel cost 3= 30% increment from current travel cost 4= 40% increment from current travel cost 5= 50% increment from current travel cost 6= 60% increment from current travel cost
TRAVEL TIME	Increment of total travel time from home to final destination and for the return journey, 1= 5 minutes increment from current travel time 2= 10 minutes increment from current travel time 3= 20 minutes increment from current travel time 4= 30 minutes increment from current travel time 5= 40 minutes increment from current travel time
ACCESS COST	Out-of- pocket cost decrement from home to rail station, 1= 10% decrement from current access cost 2= 20% decrement from current access cost 3= 30% decrement from current access cost 4= 40% decrement from current access cost 5= 50% decrement from current access cost 6= 60% decrement from current access cost
ACCESS TIME	Decrement of access time form home to rail station, 1= 5 minutes decrement from current access time 2= 10 minutes decrement from current access time 3= 20 minutes decrement from current access time 4= 30 minutes decrement from current access time 5= 40 minutes decrement from current access time
ACCESS DISTANCE	Decrement of access distance from home to rail station, 1= 100m decrement from current access distance 2= 300m decrement from current access distance 3= 500m decrement from current access distance 4= 700m decrement from current access distance 5= 900m decrement from current access distance 6= 1000m decrement from current access distance
RAIL FREQUENCY	Increment of rail frequency per hour 1= From 6 to 7 times per hour 2= From 6 to 8 times per hour 3= From 6 to 9 times per hour 4= From 6 to 10 times per hour 5= From 6 to 11 times per hour 6= From 6 to 12 times per hour

Table 4.6 depicted the variables, which were used in Binomial Logistic Regression analysis. As previously mentioned, six hypothetical case scenarios were designed for frequent rail users, while seven hypothetical case scenarios were designed for private

transport users. For each hypothetical scenario level, the frequent rail users were asked whether they will shift to private transport mode or travel consistently with rail, whereas the private transport users were asked whether they will shift to rail transit or travel consistently with private transport. Based on table 4.6, the coding for each scenario level for frequent rail users is in ordinal scale and was arranged parallel with the travel attributes increment except for rail frequency scenario, which was arranged in decrement. Similarly, for private transport users, the coding for each scenario level was also arranged in ordinal scale and parallel with the travel attributes increment except for access cost, access time and access distance scenarios, which was arranged in decrement. Later on, the utility functions of travel mode choice preference for each scenario and probability of shifting for frequent rail users and private transport users will be presented and discussed in the following sub-sections. The application of discrete choice modelling approach in modelling to mode choice behaviour of frequent and private transport users can be an important tool to determine which improvements are the most needed and what are the impact of these improvements to rail transit ridership and travel modal share (Fillone et al., 2008).

4.8.2 Model Estimation Results for Frequent Rail Users Analysis

The results from the previous analysis were used for Binomial Logistic Regression (BNL) models that discuss the travel behaviour change, i.e. the likelihood to shift to private transport mode and at the same time discussed the likelihood of frequent rail users to consistently travel with rail transit despite increment in their daily travel conditions. In discrete choice models, the probability of choosing or shifting to particular alternative is proportional to the differences between its estimated utility and the estimated utility of other available alternatives (Bergman et al. 2009). The utility function, U, has the property that an alternative is chosen if its utility is greater than the utility of all other alternatives in the individual's choice set (Koppelman & Bhat, 2006). The interaction of each attribute in a utility function of a mode is presented by its regression coefficients, B that is estimated using maximum likelihood methods. The positive values of the regression coefficients apply a positive impact while negative values apply a negative impact on the utility function.

For this analysis, the dependent choice variable represented the probability of shifting to private transport in daily trip. The variable is coded 1 if frequent rail users shift to private transport, and 0 if the frequent rail users travel consistently with rail. In addition, the rail transit mode was set as a reference category. In this analysis, the numbers of samples used in analysis were from 245 respondents (frequent rail users). Originally, the overall numbers of frequent rail users were 325. However, it was discovered that only 245 respondents completed the questions on stated preference scenarios. The samples distribution for descriptive statistics in the analysis was tabulated in Table 4.7.

Table 4.7: Distribution socio-demographic and daily travel trip of frequent rail users

Variable	Level/Code	(%)	Variable	Level/Code	(%)
Gender	0 = Male 1 = Female	46.1 53.9	*Licensed driver*	0 = No 1 = Yes	27.8 72.2
Age	1 = 18–24 2 = 24–30 3 = 31–40 4 = 41–50 5 = 51–60 6 = 61 and above	40.0 28.6 18.8 7.3 4.1 1.2	*Availability of vehicle*	1 2 3	76.7 22.9 0.4
Access mode	0 = Walking 1 = Other access mode	44.9 55.1	*Travel purpose*	0 = Workplace 1 = Other purpose	70.6 29.4

‘Table 4.7, continued’

Variable	Level/Code	(%)	Variable	Level/Code	(%)
Job status	1 = Pensioner/Housewives	3.3	*Monthly income*	1 = ≤ RM1000	31.8
	2 = Student	26.1		2 = 1001–2000	22.0
	3 = Blue collar jobs	12.2		3 = 2001–3000	18.0
	4 = White collar jobs	22.9		4 = 3001–4000	13.9
	5 = Self-employed/	1.2		5 = 4001–5000	3.3
	Business man	11.4		6 = ≥ 5001	11.0
	6 = Management/Executive	22.9			
	7 = Professional				
Highest education	1 = Primary/Secondary School	24.5	*Number of trips (per week)*	1 = 8–9 trips	15.9
	2 = Pre-University/Diploma	28.2		2 = 10–11 trips	77.6
	3 = Degree	39.2		3 = 12 trips	6.5
	4 = Postgraduate (Master/PhD)	8.2			
Variable		(%)	Variable		(%)
Access distance from home to rail station			*Access time from home to rail station*		
0-500m		31.8	0-10 minutes		67.8
501-1000m		16.3	11-20 minutes		21.6
1001-1500m		2.0	21-30 minutes		8.6
1501-2000m		5.3	31-40 minutes		1.6
More than 2000m		44.5	41-50 minutes		0.4
Median, Md.		1250.5m	*Mean, M*		12.0 mins.
Standard deviation, SD		1.806	*Standard deviation, SD*		0.754
Access cost from home to rail station			*Travel distance from home to station and for the return journey*		
RM0-RM1.90		69.8/45.2	0-10km		1.6
RM2.00-RM3.90		18.0/32.6	11-20km		33.9
RM4.00-RM5.90		10.6/19.3	21-30km		32.2
RM6.00-RM7.90		1.6/3.0	31-40km		11.8
Mean (include walking/exclude walking)		RM1.30/ RM2.30	More than 40km		20.4
Standard Deviation, SD		0.75/0.85	*Median, Md.*		25.5km
			Standard deviation, SD		1.149
Travel time from home to station and for the return journey			*Travel cost from home to station and for the return journey*		
11-20 minutes		0.8	RM0-RM1.90		2.0
21-30 minutes		3.7	RM2.00-RM3.90		14.7
31-40 minutes		2.0	RM4.00-RM5.90		22.0
41-50 minutes		6.9	RM6.00-RM7.90		21.6
51-60 minutes		8.2	RM8.00-RM9.90		13.9
61-70 minutes		9.4	RM10.00-RM11.90		9.8
71-80 minutes		10.2	RM12.00-RM13.90		4.9
81-90 minutes		11.4	RM14.00-RM15.90		4.9
91-100 minutes		9.8	RM16.00-RM17.90		4.9
> 100 minutes		37.6	RM18.00-RM19.90		1.2
Mean, M		91.0 mins	*Mean, M*		7.60
Standard deviation, SD		2.462	*Standard deviation, SD*		2.062

From the analysis, it was found that the percentage of females using rail transit is slightly higher (7.8% difference) than males with majority of frequent rail transit users are younger riders, aged between 18 to 30 years old (68.6%). As for employment status, white-collar jobs, professionals, and students are the frequent users of rail transit system, which contribute to 71.9% with 39.2% of them, having a degree qualification. In terms of income, 68.2% of the frequent rail transit users have income of more than RM1,000 per month. Additionally, it was also revealed that 27.8% of the respondents do not have driving licenses but it was discovered that all of them have available vehicles for the journey, either of their own or their household vehicles. As for the purpose of travel, as expected, more than 70.0% of the respondents use rail transit for work trips. In this study, it was identified that walking mode share from home to rail transit station showed encouraging value as compared to other access modes (44.9%). Furthermore, majority of frequent rail users travelled between 10–11 trips per week. As for access cost, about 28.1% of the frequent rail users spent more than RM2.30 for their access cost. In addition, about 32.2% of the frequent rail users took more than 10 minutes to reach the rail transit station from home. About 51.8% of the frequent rail transit users are living more than 1,000m away from the rail transit stations. In average, the frequent rail users travelled 91.0 minutes for their travel time and spent RM7.50 for their ravel cost.

The summary of model estimation results using Binomial Logistic Regression (BNL) analysis with respect to different scenario of access cost increment, access time increment, access distance increment, travel cost increment, travel time increment and rail frequency decrement are presented in the following subsections. For Scenario 1, the numbers of observations were obtained from 110 samples. The numbers of samples were less than stated previously because frequent rail users who are walking (access mode) from home to rail transit station was excluded in access cost increment scenario analysis. Meanwhile, the numbers of observation for Scenario 2 until Scenario 6 were 245 samples.

4.8.2.1 Scenario 1: Access Cost Increment (Exclude Walking)

A summary of the estimations from the model is presented in Table 4.8. The maximum likelihood estimates of the constant and predictor variables are presented under the column heading Estimated Coefficient, *B*. The estimated parameter will provide the clues on how the predictors contributed to the probability of shifting to private transport under access cost increment scenario. The standard errors of the B estimates are given under the column SE and the squared ratios of the estimates to their respective standard errors are given under the column Wald. The observed significance levels of the tests (i.e. the p = values) are given under the column Sig. As previously mentioned, the dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the frequent rail users who will shift to private transport if the access cost is about to increase and value 0 for those which will not shift to private transport and will travel consistently with rail transit. A value of odds ratio, Exp(B) < 1 which corresponds to a decrease in the odds of the dependent variable while a value of odds ratio, Exp(B) > 1 means the more the variable is independent of the dependent variable. The objective was to investigate whether a set of predictor variables comprising socio-demographic characteristics such as gender, age, job, income, license, vehicle availability, educational levels, travel purpose, number of trips and access cost increment could be used to predict the probability of shifting to private transport. The study found that out of the 10 predictor variables entered in the analysis, five predictor variables were found to be significant at least at p = 0.05 level.

Table 4.8: Estimations from the Binary Mode Choice Model for Access Cost Scenario Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	0.095	0.171	0.310	1	0.578	1.100	0.787	1.537
Age	-0.092	0.091	1.019	1	0.313	0.912	0.764	1.090
Job	0.100	0.093	1.165	1	0.280	1.105	0.922	1.326
Income	*0.228*	*0.115*	*3.926*	*1*	*0.048*	*1.256*	1.002	1.574
License(1)	*0.749*	*0.224*	*11.175*	*1*	*0.001*	*2.116*	1.363	3.283
Vehicle availability	*-1.164*	*0.248*	*21.996*	*1*	*0.000*	*0.312*	0.192	0.508
Education	-0.176	0.130	1.836	1	0.175	0.839	0.651	1.082
Travel purpose(1)	*0.736*	*0.311*	*5.595*	*1*	*0.018*	*2.088*	1.135	3.843
No. of trips per week	0.182	0.109	2.819	1	0.093	1.200	0.970	1.485
Access cost increment	*0.068*	*0.005*	*156.698*	*1*	*0.000*	*1.070*	1.059	1.082
Constant	*-3.972*	*1.233*	*10.379*	*1*	*0.001*	*0.019*	0.787	1.537
<u>*Summary of statistics*</u>								
(-2) log likelihood	887.220							
Model chi-square	235.501							
Cox & Snell R^2	0.252							
Nagelkerke R^2	0.336							
Number of observations	*135*							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as the reference. The positive sign of access cost indicated that an increase in access cost from home to rail station is likely to increase the probability of frequent rail transit users shifting to private transport mode (*B* = 0.068). It is interesting to note that frequent rail users with higher monthly income were more sensitive towards access cost increment. This can be explained by the fact that in the current study, about 39.0% of frequent rail users with monthly income of more than RM3,000 and above were using taxi, park and ride and, drop-off to reach rail station from home. The increment of motorized access mode cost will become a strong deterrent to frequent rail users because any access cost increment will indirectly affect overall travel cost for the trips.

As expected, frequent rail users with driving license were two times more likely to shift to private transport as compared to frequent users without driving license. It was found that frequent rail users with more vehicles were less likely to shift to private transport than frequent rail users with fewer vehicles by access cost increment. A possible explanation for this might be that frequent rail users will use their extra vehicles as access mode to rail station rather than travel directly from home to their workplace if the access cost is about to increase. In addition, the odds ratio of 0.312 for vehicle availability was less than 1, indicating that for every additional or extra vehicles (more than one vehicle), frequent rail users were 0.312 times less likely to shift to private transport, controlling for other factors in the model.

The purpose of travel had a statistically significant contribution to the explanation of frequent rail users shifting behaviour. It was discovered that frequent rail users who used rail transit because of other trip purposes rather than work trips were more likely to shift to private transport by access cost increment. In other words, frequent rail users who used rail transit for work were less likely to shift to private transport with respect to access cost increment. This is probably because of their concerns on travel behaviour and cost parameter. The frequent rail users who used rail transit for work daily travel more frequent in comparison to other users who used rail for education, social and personal purposes. This finding probably similar to Meloni et al., (2013) which found that individuals who depended on car usage as their daily travel mode are difficult to be influenced to change (inertia effect). However, frequent rail users who used rail for work travel more in terms of distance as compared to others who used rail for other purposes. This was also highlighted and supported in Meloni et al. (2013), which discovered that individuals who travel more than 25k kilometres each year are less likely to change their travel mode behaviour. In addition, by excluding who walked to rail station, majority of frequent rail users (45.2%) spent below RM2.00 for their daily access cost. Therefore, the frequent rail users who used rail for work would probably consider that the access cost increment is still affordable and cheaper as compared to travel directly from home to rail station by private transport. Other than that, that would also be beneficial in terms of parking facilities around the rail station because users with work-related purposes have the longest parking duration, and travel during peak hours (Simićević et al., 2012). The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.9 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.16 and 4.17. This test was carried out in order to assess how well the model fitted the data and was recognized as the most reliable test of model fit in SPSS (Pallant, 2007).

Table 4.9: Hosmer and Lemeshow's Test for Access Cost Increment Scenario

		Rail transit		Private transport		Total
		Observed	Expected	Observed	Expected	
Step 1	1	73	72.423	8	8.577	81
	2	71	66.715	11	15.285	82
	3	61	60.939	21	21.061	82
	4	51	52.934	30	28.066	81
	5	43	45.286	38	35.714	81
	6	35	37.111	46	43.889	81
	7	32	28.905	49	52.095	81
	8	17	22.296	65	59.704	82
	9	15	15.505	66	65.495	81
	10	13	8.887	65	69.113	78
	Chi-square		df		Sig.	
	6.619		8		0.578	

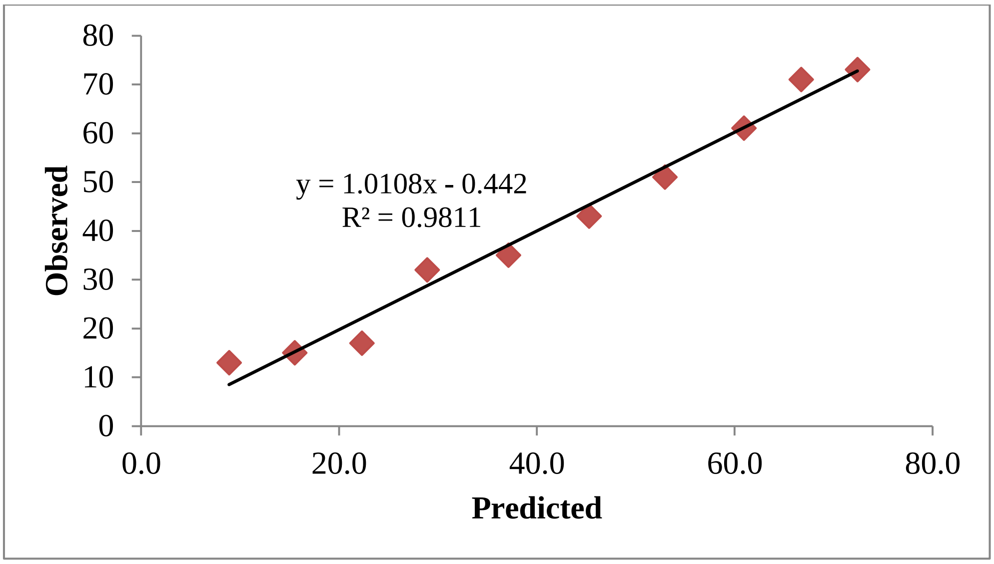

Figure 4.16: Predicted versus Observed Values by Rail Transit with Respect to Access Cost Increment

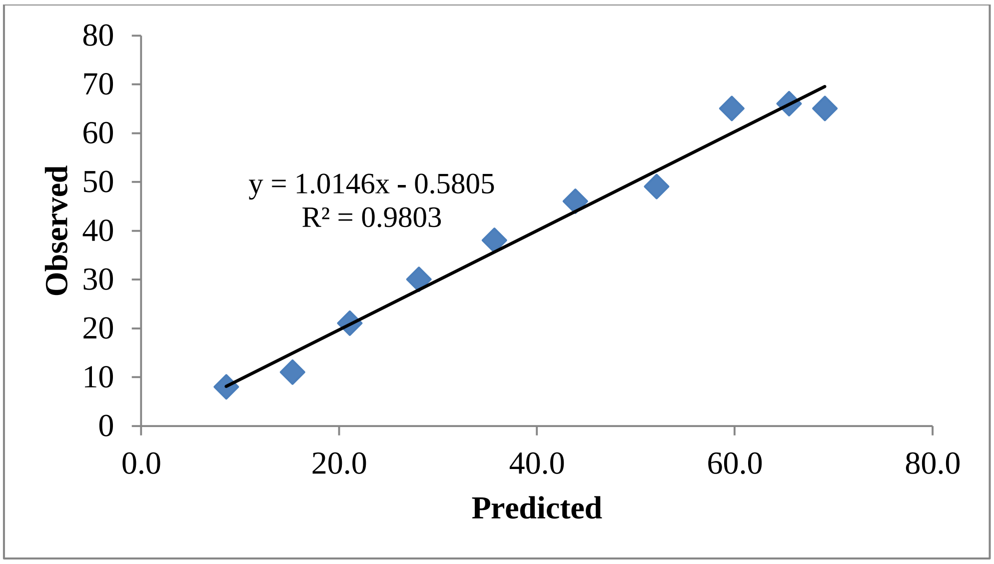

Figure 4.17: Predicted versus Observed Values by Private Transport with Respect to Access Cost Increment

Based on Table 4.9, Figure 4.16 and Figure 4.17, it was discovered that there was minor differences between the observed and predicted values for both modes of transport as evidenced by the Chi-square value with a significance level of 0.578. This value is larger than 0.05, which indicated good fit and support the model. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to access cost increment, the full model as tabulated in Table 4.8 containing all predictors was statistically significant, χ^2 (10, N = 135) = 235.501, $p < 0.05$, indicating that the model was able to distinguish between frequent rail users who will travel by rail and who will travel by private transport. The model as a whole explained between 25.2% (Cox & Snell R squared) and 33.6% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 72.5% of the rail transit cases and 73.4% of the private transport cases. In overall, the prediction was correctly classified 73.0% of cases, an improvement over the 50.7% in Block 0 (model without any of independent variables).

4.8.2.2 The Probability of Shifting with Respect to Access Cost Increment

The mode share probabilities was calculated by solving the binary logit equation for probability using a range of access cost increment which was asked in the questionnaire previously while keeping the other variables constant (according to the mean values). The probability of shifting to private transport mode is compared to rail transit mode (reference category). Based on Table 4.8, the binary logit equation for shifting probability to private transport mode with respect to access cost increment is listed as below;

$$P = \frac{\text{EXP}\,((-3.972 + (0.095^*\text{Gender}) - (0.092^*\text{Age}) + (0.100^*\text{Job}) + (0.228^*\text{Income}) + (0.749^*\text{License}) - (1.164^*\text{Vehicle Availability}) - (0.176^*\text{Education}) + (0.736^*\text{Travel Purpose}) + (0.182^*\text{Number of trip}) + (0.068^*\text{Access Cost Increment}))}{(1 + \text{EXP}\,(-3.972 + (0.095^*\text{Gender}) - (0.092^*\text{Age}) + (0.100^*\text{Job}) + (0.228^*\text{Income}) + (0.749^*\text{License}) - (1.164^*\text{Vehicle Availability}) - (0.176^*\text{Education}) + (0.736^*\text{Travel Purpose}) + (0.182^*\text{Number of trip}) + (0.068^*\text{Access Cost Increment})))}$$

The mode share probabilities of rail transit and private transport mode with respect to access cost increment (exclude walking) is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.18 below.

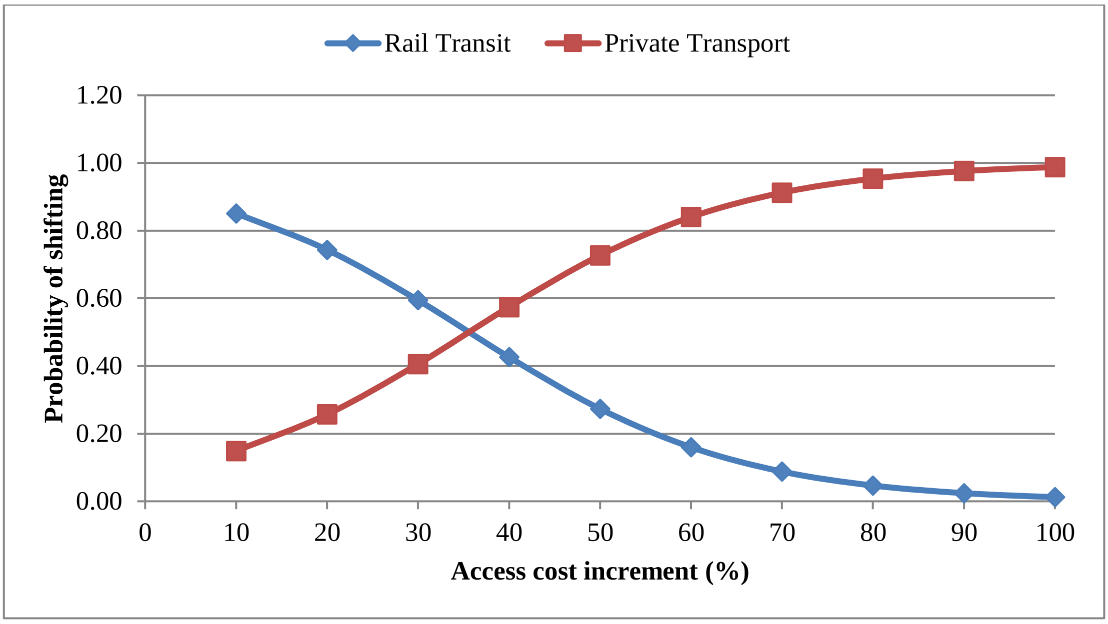

Figure 4.18: Probability of Shifting to Private Transport Mode With Respect to Access Cost Increment.

The probability of shifting depicted stimulating tendency towards private transport mode by increment of current access cost from 10% until 100%. The mode choice probabilities were 15.0% likelihood to private transport with 10% access cost increment to 100.0% likelihood if the access cost was increased to 100% from their current access cost expenses. Simultaneously, probability of using rail transit decreased from 85.0% likelihood to 0.0% likelihood when the access cost was increased from 10% to 100% of current access cost spending. It was predicted that a 50:50 split may be achieved when the access cost increment reached 36%. It was suggested that frequent rail users treated 36% as the maximum increment of current access cost that they will tolerate before the likelihood to private transport continuous gradually and likelihood to travel with rail decreased continuously. Based on the current access cost in this study, the maximum access cost that the frequent rail users would tolerate is RM3.10. This is because any access cost increment will directly influence the travel cost of daily trips for frequent rail transit users. In addition, a 100% shifting from rail to private transport was possibly achievable when the access cost was set at RM4.60 per trip (including the return journey). Based on the current data, it was identified that about 9.0% of frequent rail users spent above RM4.60 for their access cost. In other words, majority of frequent rail users were satisfied with their current access cost from home to station. Therefore, any access cost increment in the future will strongly affect their daily travel mode. This finding can be proposed as an important indicator to transport planners and service operators in deciding affordable access cost for frequent rail transit users.

4.8.2.3 Scenario 2: Access Time Increment

A summary of the estimations from the model with respect to access time increment was presented in Table 4.10. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the frequent rail users who will shift to private transport if the access cost is about to increase and value 0 for those which will not shifting to private transport and travel consistently with rail transit. The study found that out of the 11 predictor variables entered in the analysis, three predictor variables were found to be significant at least at the 0.05 level.

Table 4.10: Estimations from the Binary Mode Choice Model for Access Time Scenario Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	-0.028	0.163	0.030	1	0.863	0.972	0.707	1.337
Access mode(1)	-0.192	0.165	1.353	1	0.245	0.825	0.597	1.141

Age	-0.122	0.089	1.865	1	0.172	0.885	0.743	1.054
Job	-0.131	0.086	2.292	1	0.130	0.878	0.741	1.039
Income	*0.356*	*0.111*	*10.250*	*1*	*0.001*	*1.428*	*1.148*	*1.775*
License(1)	0.274	0.189	2.104	1	0.147	1.316	0.908	1.906
Vehicle availability	0.291	0.246	1.404	1	0.236	1.338	0.827	2.165
Education	-0.107	0.119	0.804	1	0.370	0.899	0.711	1.135
Travel purpose(1)	*0.748*	*0.296*	*6.384*	*1*	*0.012*	*2.112*	*1.183*	*3.772*
No. of trips per week	0.084	0.102	0.677	1	0.411	1.088	0.890	1.329
Access time increment	*0.154*	*0.008*	*351.647*	*1*	*0.000*	*1.166*	*1.148*	*1.185*
Constant	-4.118	1.158	12.655	1	0.000	0.016		
<u>*Summary of statistics*</u>								
(-2) log likelihood		1034.866						
Model chi-square		647.991						
Cox & Snell R^2		0.411						
Nagelkerke R^2		0.550						
Number of observations		245						

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as the reference. The positive sign of access time indicated that an increase in access time from home to rail station was likely to increase the probability of frequent rail transit users shifting to private transport mode. Therefore, the null hypothesis that the coefficients (B) is equal to zero for these independent variables was rejected.

As expected, the monthly income variable was positive by access time increment. Positive coefficient indicated that frequent rail users with higher income are more likely to shift to private transport mode for their daily trip if access time is about to increase. This indicated that the commuters getting higher income were less sensitive to travel fares, and is willing to spend more as long as they arrive punctually to their work place (Ashiabor et al., 2007a; Ashiabor et al., 2007b; Miskeen et al., 2013).

In addition, it was discovered that frequent rail users making other trip purposes rather than work trips were more likely to shift to private transport by access time increment. Shifting likelihood to private transport might be due to the availability parking facilities at and around the rail station because users with work-related purposes have the longest parking duration, and travel during peak hours (Simićević et al., 2012). The possibility to shift to private transport was likely to happen because they considered their private transport as an alternative daily travel mode if access time from home to rail station are about to increase. In addition, this result may be explained by the fact that any access time increment will affect the overall travel time of frequent rail users (Rodriguez & Targa, 2004; Redman *et al*., 2013).

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.11 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.18 and 4.19.

Table 4.11: Hosmer and Lemeshow's Test for Access Time Increment Scenario

		Rail transit		Private transport		
		Observed	Expected	Observed	Expected	Total
Step 1	1	118	111.682	5	11.318	123
	2	109	105.045	14	17.955	123
	3	97	99.718	28	25.282	125
	4	81	85.644	42	37.356	123
	5	53	59.650	69	62.350	122
	6	45	41.181	78	81.819	123
	7	16	21.011	106	100.989	122
	8	4	12.095	119	110.905	123
	9	17	5.241	105	116.759	122
	10	4	2.733	115	116.267	119
	Chi-square		df		Sig.	
	43.707		8		0.000	

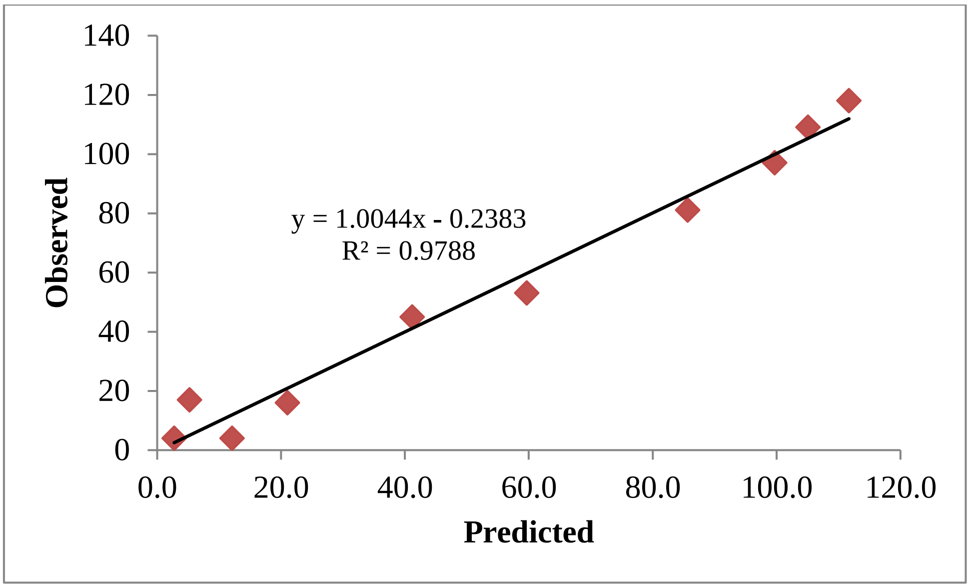

Figure 4.19: Predicted versus Observed Values by Rail Transit with Respect to Access Time Increment

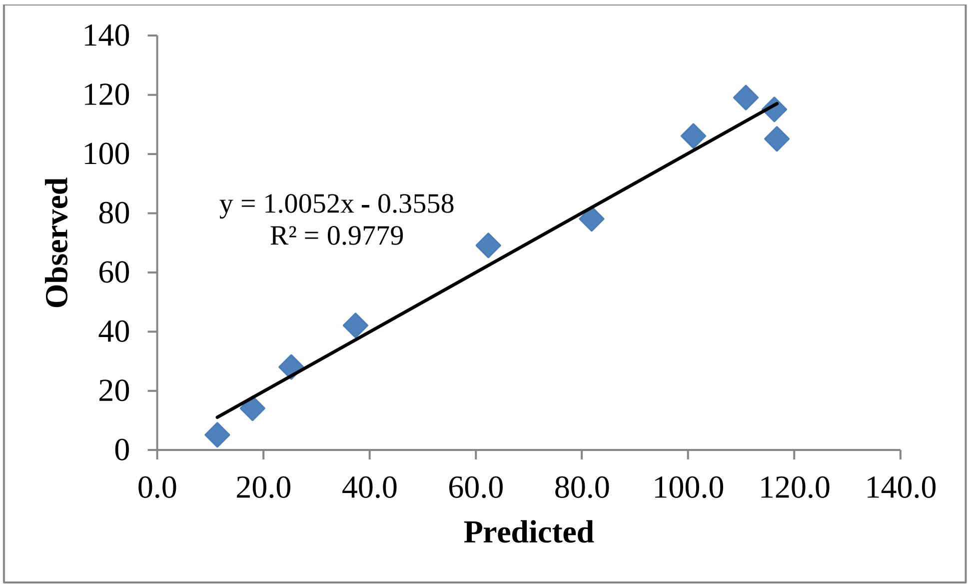

Figure 4.20: Predicted versus Observed Values by Private Transport with Respect to Access Time Increment

Based on the results as presented in Table 4.11, Figure 4.18 and Figure 4.19, it was discovered that there were minor differences between the observed and predicted values for both modes of transport. The Chi-square value for the Hosmer-Lemeshow Test is

43.707, with significance level of less than 0.05, indicating a poor fit. However, a significant Hosmer-Lemeshow test does not necessarily mean that predictive models are not useful or doubtful. The significant Hosmer-Lemeshow test statistic was probably due to large sample size as any discrepancy between the model and the data will be magnified as number of samples increased, resulting in small p-values for a goodness of fit test (Marcin and Romano, 2007). The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to access time increment, the full model as tabulated in Table 4.10 containing all predictors was statistically significant, χ^2 (11, N = 245) = 647.991, $p < 0.05$, indicating that the model was able to distinguish between frequent rail users who will travel by rail and who will travel by private transport, respectively. The model as a whole explained between 41.1% (Cox & Snell R squared) and 55.0% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 78.5% of the rail transit cases and 83.7% of the private transport cases. In overall, the prediction was correctly classified 81.4% of cases, an improvement over the 55.6% in Block 0 (model without any of independent variables, IVs).

4.8.2.4 The Probability of Shifting with Respect to Access Time Increment

The mode share probabilities of rail transit and private transport mode with respect to access time increment is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.21. The probability of shifting to private transport mode is compared to rail transit mode (reference category). Based on Table 4.10, the binary logit equation for shifting probability to private transport mode with respect to access time increment scenario is listed as below;

$$P = \frac{EXP(-4.118 - (0.028*Gender) - (0.192*Access\ Mode) - (0.122*Age) - (0.131*Job) + (0.356*Income) + (0.274*License) + (0.291*Vehicle\ Availability) - (0.107*Education) + (0.748*Travel\ Purpose) + (0.084*Number\ of\ trip) + (0.154*Access\ Time\ Increment))}{(1 + EXP(-4.118 - (0.028*Gender) - (0.192*Access\ Mode) - (0.122*Age) - (0.131*Job) + (0.356*Income) + (0.274*License) + (0.291*Vehicle\ Availability) - (0.107*Education) + (0.748*Travel\ Purpose) + (0.084*Number\ of\ trip) + (0.154*Access\ Time\ Increment)))}$$

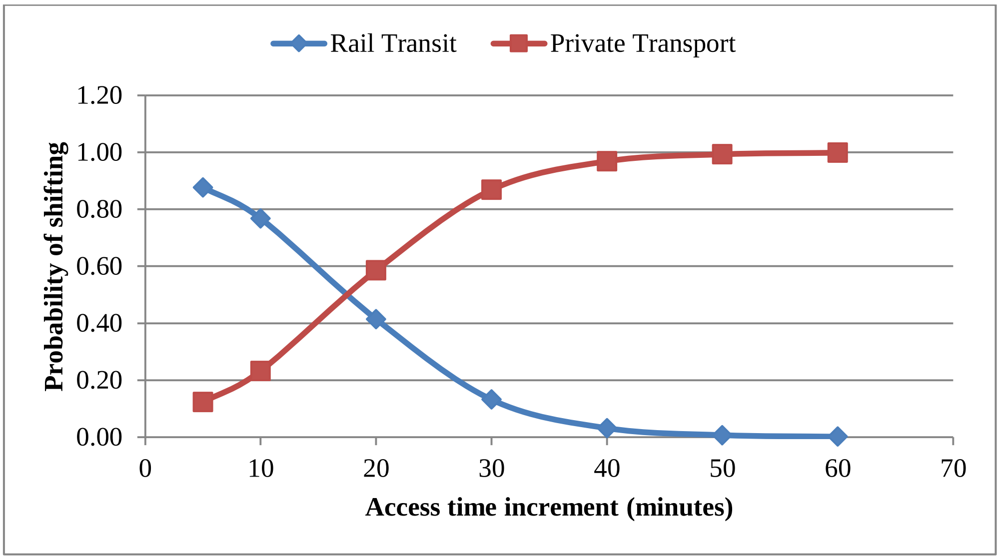

Figure 4.21: Probability of Shifting to Private Transport Mode With Respect to Access Time Increment

It is shown that the probability of shifting showed stimulating tendency to private transport to increase from 12.0% to 100.0% likelihood by increment of 5 minutes to 60 minutes from their current access time. Simultaneously, it was predicted that the probability of using rail transit shows a reduction from 88.0% to 0.0% likelihood by increment of 5 to 60 minutes from their current access time. A 50:50 split was attained when access time increment reached 18 minutes. This value was suggested as maximum access time increment that frequent rail users will tolerate before they shifted to private transport mode gradually. Based on the current access time in this study, the proposed maximum access time that the frequent rail users would tolerate is 30 minutes. Based on current data, about 2.0% of frequent rail users took more than 30.0 minutes to access rail station from home. In addition, it is interesting to observe that the shifting probability to private transport reached 100% when access time increment increased to 60 minutes. It is suggested that frequent rail users are vulnerable towards access time increment as the access time will directly influence overall travel time. The longer the travel time, the less accessible a person's experience is (Recker et al., 2001; Lau & Chiu, 2003; Redman et al., 2013). This finding showed significant influence of access time in frequent rail user's daily trip because any access time increment will affect overall travel time of frequent rail users (Rodriguez & Targa, 2004; Redman et al., 2013).

4.8.2.5 Scenario 3: Access Distance Increment

A summary of the estimations from the model with respect to access distance increment was presented in Table 4.12. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the frequent rail users who will shift to private transport if the access distance is about to increase and value 0 for those which will not shifting to private transport and travel consistently with rail transit. The study found that out of the 11 predictor variables entered in the analysis, five predictor variables were found to be significant at least at the 0.05 level.

Table 4.12: Estimations from the Binary Mode Choice Model for Access Distance Scenario Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	*-0.463*	*0.173*	*7.143*	*1*	*0.008*	*0.629*	*0.448*	*0.884*
Access mode(1)	*-0.588*	*0.176*	*11.122*	*1*	*0.001*	*0.556*	*0.393*	*0.785*
Age	0.026	0.094	0.076	1	0.783	1.026	0.854	1.233

Job	0.083	0.091	0.837	1	0.360	1.087	0.909	1.298
Income	0.038	0.116	0.107	1	0.743	1.039	0.827	1.304
License(1)	0.325	0.200	2.653	1	0.103	1.384	0.936	2.046
Vehicle availability	*-0.981*	*0.262*	*14.039*	*1*	*0.000*	*0.375*	*0.224*	*0.626*
Education	-0.108	0.126	0.738	1	0.390	0.897	0.701	1.149
Travel purpose(1)	*0.685*	*0.313*	*4.792*	*1*	*0.029*	*1.983*	*1.074*	*3.660*
No. of trips per week	0.000	0.108	0.000	1	0.998	1.000	0.809	1.235
Access distance increment	*0.008*	*0.000*	*408.538*	*1*	*0.000*	*1.008*	*1.007*	*1.009*
Constant	*-2.660*	*1.214*	*4.805*	*1*	*0.028*	*0.070*		
Summary of statistics								
(-2) log likelihood	954.240							
Model chi-square	1007.058							
Cox & Snell R^2	0.496							
Nagelkerke R^2	0.673							
Number of observations	245							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as the reference. The positive sign of access distance coefficient indicated that an increase in access distance from home to rail station was likely to increase the probability of frequent rail transit users shifting to private transport mode choice.

With respect to gender, the model estimation suggested that females were more likely to travel with rail than shifting to private transport by access distance increment. In other words, male users are more sensitive to access distance increment. Females were 13.0% more likely to travel consistently with rail transit as compared to males. A possible explanation for this might be because female prefer to drive short distance to the rail station rather than the long distance to the work place. This finding is in line with previous research which reported that females were more likely to travel with public transport and less commute with auto because their travel distance tend to be shorter than males and drove less than males (Schwanen & Mokhtarian, 2005; Miskeen et al., 2013). Contradictory to present findings, Kamba et al. (2007) reported that females are more likely to travel by car than by bus and rail for their journey.

Another unanticipated finding was access mode factor, which was negatively influencing the probability of shifting to private transport mode by access distance increment. The frequent rail users who are using motorized access modes were less likely to shift to private transport mode as compared to those who are walking to rail station. This is because they have access to vehicles or public transport, namely, taxi and bus as their access modes and any increment on their access distance might not bring huge influence on their current choice of travel mode. Another explanation is this result suggested a low preference among frequent rail users in shifting travel mode due to inertia effects or past experiences influence on the present choice (Meloni, et al., 2013; Cantillo, et al., 2007; Cherchi & Manca, 2011). In specific, it has to do with the tendency to maintain with the past choice even when another choice becomes more attractive. The result of this study has pointed out that past behaviour is a strong predictor of future behaviour Meloni, et al., 2013,Cherchi, 2009; Gärling & Axhausen, 2003). Other than that, it was also discovered that the vehicle availability factor showed significant difference in influencing frequent rail users to shift to private transport mode by access distance increment. It was discovered that as the number of vehicles increased, frequent rail users were less likely to shift to private transport. The present finding found that more than half (55.1%) of frequent rail users accessed rail transit have vehicle as an alternative access mode to rail station. In addition, about 36.3% of frequent rail users with vehicle available accessed rail station by walking. It can be interpreted that more than one quarter of the frequent rail transit are not ‘captive’ rider and may use their private transport for their journey but they choose not to use it to access the station (only 22.2%

did so). Therefore, the frequent rail users will travel consistently by rail and will use their private vehicles as their access modes or will use the drop-off facilities at the rail station if access distance is about to increase. The purpose of travel variable had statistically significant contribution to the reasons of frequent rail user's shifting behaviour with respect to access distance increment. It was discovered that frequent rail users who were using rail transit for other purposes rather than work were two times more likely to shift to private transport. The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.13 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.22 and 4.23.

Table 4.13: Hosmer and Lemeshow's Test for Access Distance Increment Scenario

		Rail transit		Private transport		Total
		Observed	Expected	Observed	Expected	
Step 1	1	146	141.620	1	5.380	147
	2	140	133.189	7	13.811	147
	3	125	114.702	22	32.298	147
	4	66	85.492	81	61.508	147
	5	36	50.155	111	96.845	147
	6	21	24.511	126	122.489	147
	7	15	10.303	131	135.697	146
	8	15	4.464	131	141.536	146
	9	3	2.371	144	144.629	147
	10	1	1.194	148	147.806	149
	Chi-square		df		Sig.	
	57.067		8		0.000	

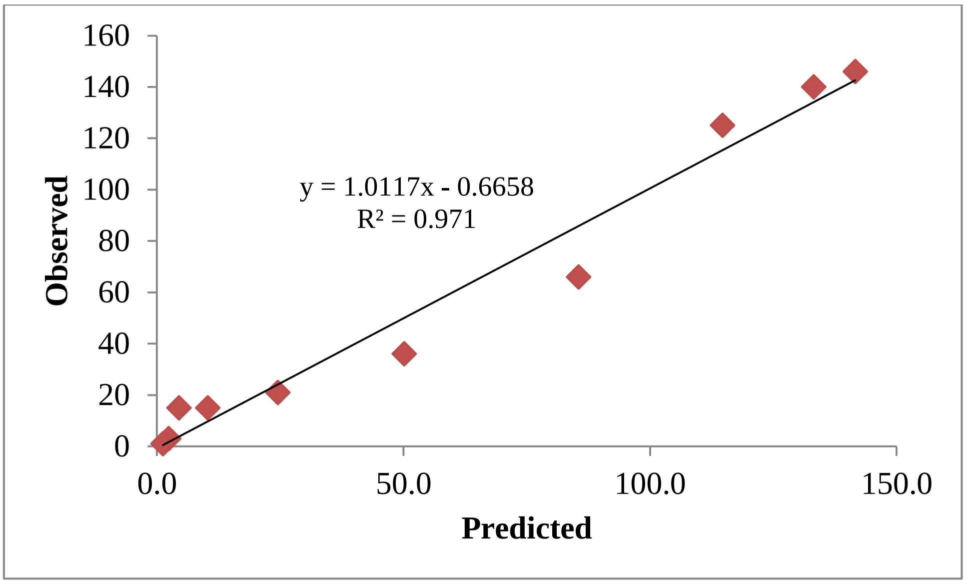

Figure 4.22: Predicted versus Observed Values by Rail Transit with Respect to Access Distance Increment

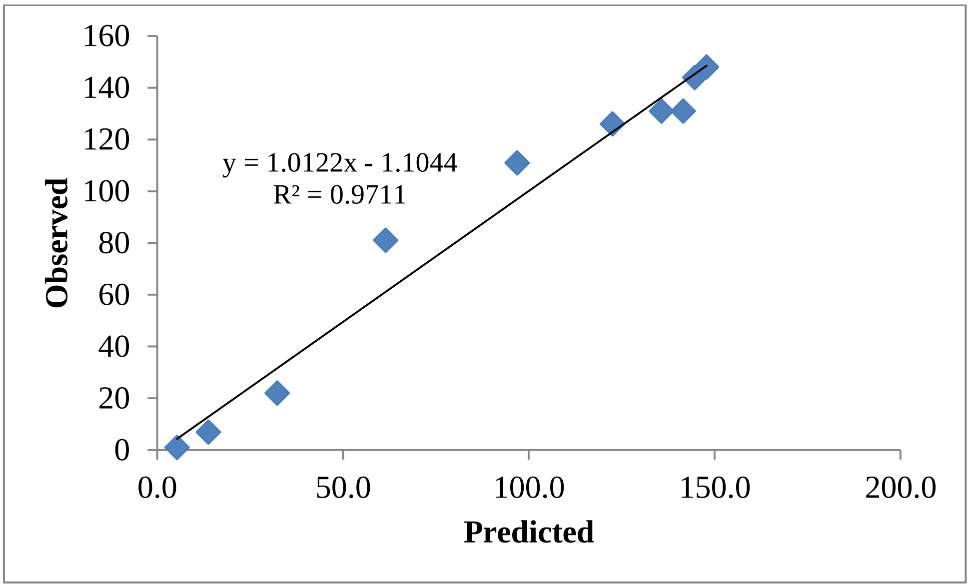

Figure 4.23: Predicted versus Observed Values by Private Transport with Respect to Access Distance Increment

Based on the results as presented in Table 4.12, Figure 4.22 and Figure 4.23, it was discovered that there were slight differences between the observed and predicted values for both modes of transport. The Chi-square value for the Hosmer-Lemeshow Test is

57.067, with significance level of less than 0.05, indicating a poor fit. This result was similar with Scenario 2: Access Time Increment. A significant Hosmer-Lemeshow test does not necessarily mean that predictive models are not useful or doubtful. The significant Hosmer-Lemeshow test statistic is due to large sample size (Marcin and Romano, 2007). With respect to access distance increment, the full model containing all predictors was statistically significant, χ^2 (11, N = 245) = 1007.058, $p < 0.05$, indicating that the model was able to distinguish between frequent rail users who will travel by rail and who will travel by private transport, respectively. The model as a whole explained between 49.6% (Cox & Snell R squared) and 67.3% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 82.9% of the rail transit cases and 89.6% of the private transport cases. In overall, the prediction was correctly classified 87.0% of cases, an improvement over the 61.0% in Block 0 (model without any of independent variables, IVs).

4.8.2.6 The Probability of Shifting with Respect to Access Distance Increment

The mode share probabilities of rail transit and private transport mode with respect to access distance increment is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.24. The probability of shifting to private transport mode is compared to rail transit mode (reference category). Based on Table 4.12, the binary logit equation for shifting probability to private transport mode with respect to access distance increment is listed as below;

P = EXP (-2.660 - (0.463*Gender) - (0.588*Access Mode) + (0.026*Age) + (0.083*Job) + (0.038*Income) + (0.325*License) - (0.981*Vehicle Availability) - (0.108*Education) + (0.685*Travel Purpose) - (0.0003*Number of trip) + (0.008*Access Distance Increment))

(1 + EXP (-2.660 - (0.463*Gender) - (0.588*Access Mode) + (0.026*Age) + (0.083*Job) + (0.038*Income) + (0.325*License) - (0.981*Vehicle Availability) - (0.108*Education) + (0.685*Travel Purpose) - (0.0003*Number of trip) + (0.008*Access Distance Increment)))

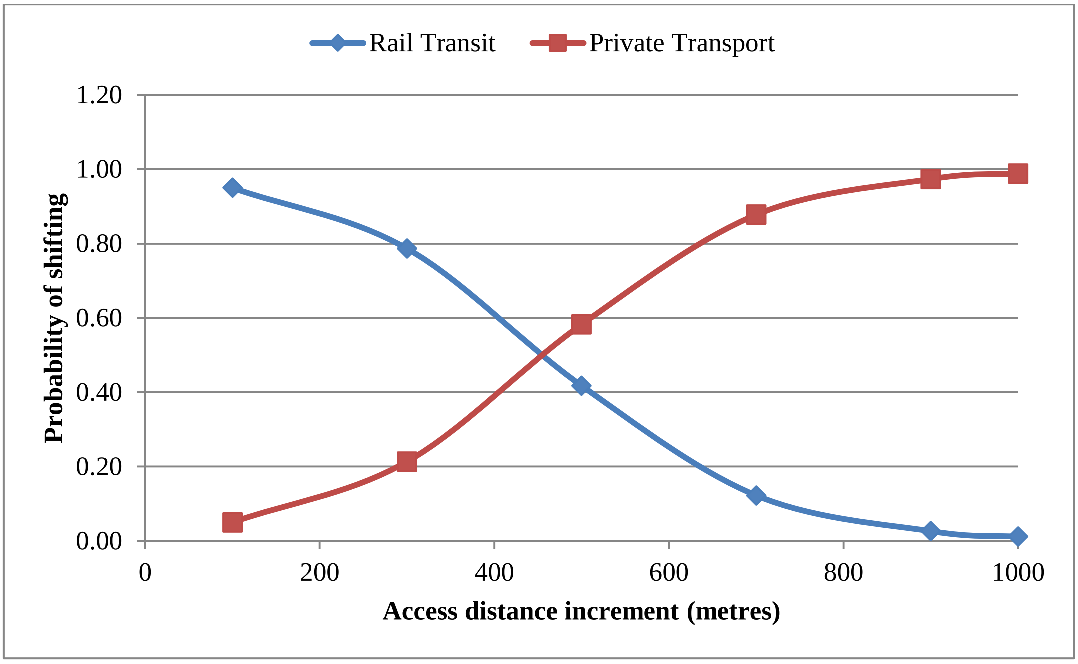

Figure 4.24: Probability of Shifting to Private Transport Mode With Respect to Access Distance Increment

The percentage of frequent rail transit users shifting to private transport increased from 5.0% to 100.0% with the increment of 100m until 1000m from their current access distance. At the same time, the probability of using rail transit was decreased from 95.0% to 0.0% with the increment of 100m until 1000m from their current access distance. A 50:50 split was attained when access distance increment reached 460m and this value was suggested as maximum access distance increment that frequent rail users will tolerate before they shifted to private transport mode. Based on the current access distance in this study, the proposed maximum access distance that the frequent rail users would tolerate is 1710.5m.

In relation to the distribution of access trips by access trip length, walking to rail station was identified as the main access mode for short access distance, which is 44.8%. In this study, short access distance was considered as equal to or less than 1000 meters. As comparison, Rastogi and Rao, (2003) considered the access distance of not more than 1250 meters as short access distance. For medium access distance, which was considered within 1001 m to 2000 m, the competition between the motorized was ambiguously displayed. However, for access distance of more than 2000 m, bus was found as the most preferred access mode as compared to taxi, park and ride and drop-off. This possibility is because of affordable bus fare, as its fare varies from a minimum of RM 1.00 (for a route length located in one zone) to RM 3.00 (for a route length located in 4 zones and more). Therefore, increment of access distance until 700 m (1950.5 m), will strongly increase the shifting probability towards private transport mode because frequent rail users considered the value as reaching the longer access distance. In addition, based on current data, 55.5% of frequent rail users travelled below 2000 m from home to rail station. It was presumed that frequent rail user's without available vehicle will use or share vehicle with their household (parent/housemate/siblings) just in case if access distance increased. Therefore, it was suggested that any access distance increment will strongly affect the decision of frequent rail users whether they will consistently travel with rail transit or shifting to other daily travel mode. Thus, by implementing appropriate facilities in relation to improvement of access mode distance e.g. by providing better service of bus and taxi, and by providing safe and more parking area, it could provide opportunities to frequent rail users to remain using rail transit and encourage more travellers to use rail as their daily travel mode.

4.8.2.7 Scenario 4: Travel Cost Increment

A summary of the estimations from the model with respect to travel cost increment was tabulated in Table 4.14. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the frequent rail users who will shift to private transport if the access cost is about to increase and value 0 for those which will not shift to private transport and travel consistently with rail transit. The study found that out of the 11 predictor variables entered in the analysis, five predictor variables were found to be significant at least at the 0.05 level. Those predictor variables were gender, access mode, vehicle availability, educational level and travel cost increment.

Table 4.14: Estimations from the Binary Mode Choice Model for Travel Cost Scenario Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	*0.947*	*0.256*	*13.679*	*1*	*0.000*	*2.579*	*1.561*	*4.260*
Access mode(1)	*0.724*	*0.258*	*7.845*	*1*	*0.005*	*2.062*	*1.243*	*3.422*
Age	-0.145	0.142	1.030	1	0.310	0.865	0.655	1.144
Job	-0.051	0.125	0.163	1	0.686	0.951	0.744	1.215
Income	-0.141	0.161	0.766	1	0.381	0.869	0.634	1.190
License(1)	-0.153	0.293	0.272	1	0.602	0.858	0.483	1.525
Vehicle availability	*1.254*	*0.352*	*12.674*	*1*	*0.000*	*3.505*	*1.757*	*6.991*
Education	*0.387*	*0.184*	*4.424*	*1*	*0.035*	*1.473*	*1.027*	*2.112*
Travel purpose(1)	-0.833	0.458	3.310	1	0.069	0.435	0.177	1.066
No. of trips per week	0.137	0.153	0.806	1	0.369	1.147	0.850	1.547

`Table 4.14, continued'

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Travel cost increment	*0.153*	*0.015*	*98.374*	*1*	*0.000*	*1.165*	*1.130*	*1.201*
Constant	-13.545	1.976	46.976	1	0.000	0.000	1.561	4.260
Summary of statistics								
(-2) log likelihood	*492.007*							
Model chi-square	*284.867*							
Cox & Snell R^2	*0.176*							
Nagelkerke R^2	*0.429*							
Number of observations	*245*							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. As expected, the positive sign of travel cost coefficients indicated that an increase in travel cost from home to rail station was likely to increase the probability of frequent rail users shifting to private transport mode. Several studies have measured travel cost to have a considerable adverse impact on the travel mode choice. As total travel cost increase, the probability of selecting or consistently travel with the mode will decrease (Kumar, et al., 2004; Kamba, et al., 2007; Miskeen, et al., 2013). In other words, the traveller's will look for cheaper or more affordable mode if their travel cost are about to increase. With respect to gender, male was used as reference group (coded as 0). The results suggested that females were 2.6 times more likely to shift to private transport mode than males. This is probably because in urban area like Klang Valley (KV), women have wider access to family vehicle. It was discovered that 10.2% of females have more than one vehicle either their owns' or their household vehicle.

Another significant variable was the access mode from home to rail station. It was discovered that frequent rail users who are using motorized access mode to reach rail station were two times more likely to shift to private transport mode if travel cost are about to increase. This is probably because any travel cost increment were highly influenced by their access cost from home to station. The access cost involved might be the fuel consumption, taxi fare, bus fare and parking rate. As expected, the frequent rail users with more than one vehicle were more likely to shift to private transport as the travel cost increase. Although there were only 12.2% of the frequent rail users that used park and ride facilities as their access mode, all of the respondents have vehicle as an alternative travel mode and any travel cost increment may influence their daily travel mode selection. Thus, it can be inferred that frequent rail users were highly influenced by the increase of travel cost rather than access cost.

In addition, it was also found that as the level of education increased, frequent rail users were more likely to shift to private transport. This is probably because frequent rail users with higher level of education are working in high paid job which permits them to buy or owns' more than one vehicle. The increment of daily travel cost, which involved the access fare, rail ticket fare and probably egress fare would affect the frequent rail users in a long run and eventually will affect the rail transit system indirectly. The current study found that 60.4% of frequent rail users were spending equal or less than average travel cost value, which was RM 7.60. In other words, 39.6% of frequent rail users experienced higher travel cost than average. Although their current average travel cost was hypothetically increased until 50% (RM11.40), frequent rail users will still continuously travel with rail and not shifting to private transport mode. A possible explanation for a low preference among frequent rail users to shift travel mode is because of inertia effects (Meloni et al., 2013; Cantillo & Ortuzar, 2007; Cherchi & Manca, 2011). Inertia effect has to do with the tendency to maintain with the past choice even when another choice becomes more attractive. The result of this study has pointed out that past behaviour is a strong predictor of future behaviour. It also suggested the existence of relationship between the inertia factor with the number of trips commuters experienced per week and overall distance travelled per year (Meloni et al., 2013; Cherchi, 2009; Garling & Axhausen, 2003).

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.15 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.25 and 4.26.

Table 4.15: Hosmer and Lemeshow's Test for Travel Cost Increment Scenario

		Rail transit		Private transport		Total
		Observed	Expected	Observed	Expected	
Step 1	1	148	147.983	0	0.017	148
	2	147	146.948	0	0.052	147
	3	147	146.864	0	0.136	147
	4	147	146.670	0	0.330	147
	5	146	145.163	0	0.837	146
	6	146	144.962	1	2.038	147
	7	143	142.024	4	4.976	147
	8	133	135.856	15	12.144	148
	9	114	120.502	33	26.498	147
	10	90	84.029	56	61.971	146
	Chi-square		df		Sig.	
	5.790		8		0.671	

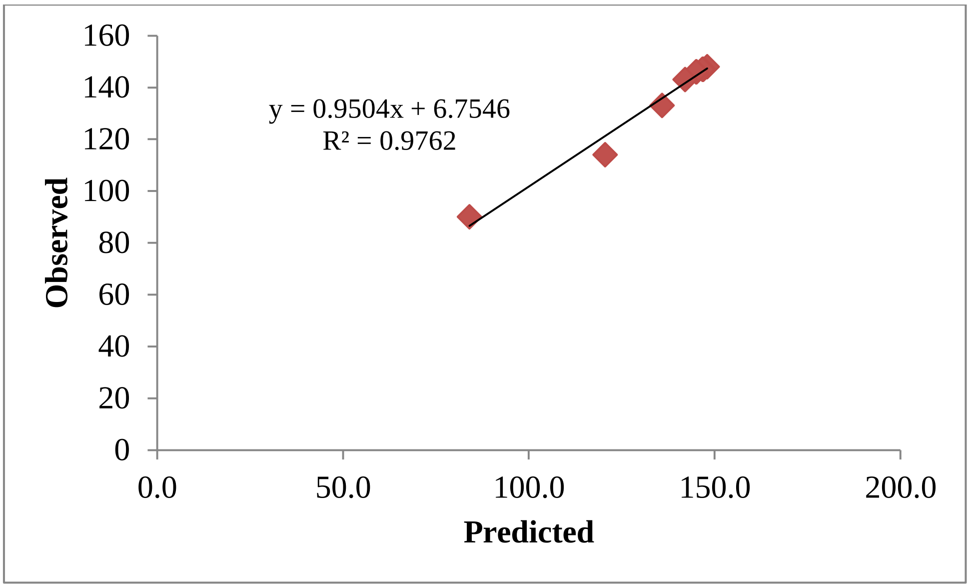

Figure 4.25: Predicted versus Observed Values by Rail Transit with Respect to Travel Cost Increment

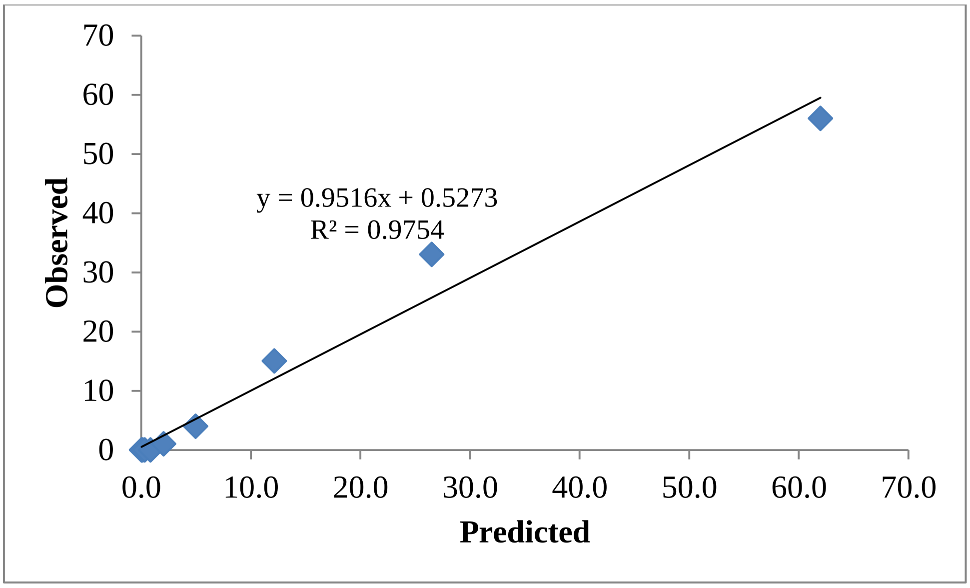

Figure 4.26: Predicted versus Observed Values by Private Transport with Respect to Travel Cost Increment

It was discovered that there was a slight difference between the observed and predicted values for both modes of transport as evidenced by the Chi-square value with a significance level of 0.671. This value is larger than 0.05, which indicated a good fit and support the model. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to travel cost increment, the full model containing all predictors was statistically significant, χ^2 (11, N = 245) = 284.867, $p < 0.05$, indicating that the model was able to distinguish between frequent rail users who will travel by rail and who will travel by private transport. The model as a whole explained between 17.6% (Cox & Snell R squared) and 42.9% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 99.2% of the rail transit cases and 20.2% of the private transport cases. In overall, the prediction was correctly classified 93.3% of cases, an improvement over the 92.6% in Block 0 (model without any of independent variables).

4.8.2.8 The Probability of Shifting with Respect to Travel Cost Increment

The mode share probabilities of private transport mode with respect to travel cost increment is exhibited in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.27. The probability of shifting to private transport is compared to rail transit mode choice (reference category). Based on Table 4.14, the binary logit equation for shifting probability to private transport mode with respect to travel cost increment is listed as below;

$$P = \frac{\text{EXP}(-13.545+(0.947*\text{Gender}) + (0.724*\text{Access Mode}) - (0.145*\text{Age}) -(0.051*\text{Job}) - (0.141*\text{Income}) - (0.153*\text{License}) + (1.254*\text{Vehicle Availability}) + (0.387*\text{Education}) - (0.833*\text{Travel Purpose}) + (0.137*\text{Number of trip}) + (0.153*\text{Travel Cost Increment}))}{(1 + \text{EXP}(-13.545+(0.947*\text{Gender}) + (0.724*\text{Access Mode}) - (0.145*\text{Age}) -(0.051*\text{Job}) - (0.141*\text{Income}) - (0.153*\text{License}) + (1.254*\text{Vehicle Availability}) + (0.387*\text{Education}) - (0.833*\text{Travel Purpose}) + (0.137*\text{Number of trip}) + (0.153*\text{Travel Cost Increment})))}$$

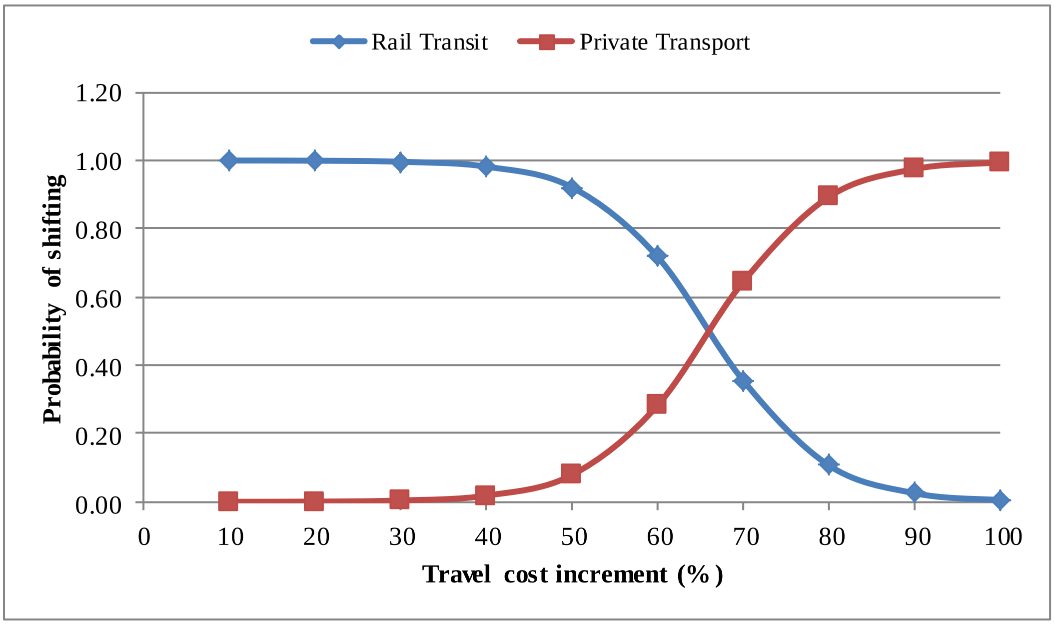

Figure 4.27: Probability of Shifting to Private Transport With Respect To Travel Cost Increment

The hypothetical scenario of travel cost was increased from 10% until 100% of current travel cost spent by frequent rail users. It was found that there is no increment of shifting probability to private transport when travel cost was increased from 10% to 30%. In addition, there is no clear trend of shifting probability to private transport until up to 50% increment of their current travel cost. In other words, the frequent rail users showed consistent tendency towards rail transit choice despite of travel cost increment. A possible explanation for this might be because 60.4% of the frequent rail users travelled below travel cost average (RM7.60) and any increment on travel cost will not influence them as much as other travel predictors. It was also suggested that frequent rail users probably estimating that the current and hypothetical travel cost increment was still in acceptable range as compared to daily travel cost spent by private transport users. However, the probability of shifting showed clear inclination towards private transport mode when the travel cost was increased until up to 100% (RM15.20). A 50:50 split was attained when travel cost increment was set at 66% (RM12.60) and this value was suggested as the maximum travel cost increment that frequent rail users will tolerate before they shift to private transport mode. The finding on shifting probability with respect to travel cost increment can be proposed as an important indicator to transport planners and service operators in deciding affordable travel cost for rail users. At the same time, improvement on rail-based transport services and related policies could as well be implemented.

4.8.2.9 Scenario 5: Travel Time Increment

A summary of the estimations from the model with respect to travel time increment was tabulated in Table 4.16. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the frequent rail users who will shift to private transport if the access cost is about to increase and value 0 for those which will not shifting to private transport and travel consistently with rail transit. The study found that out of the 11 predictor variables entered in the analysis, five predictor variables were found to be significant at least at the 0.05 level. The significant predictor variables were access mode, age, license availability, educational level and travel time increment.

Table 4.16: Estimations from the Binary Mode Choice Model for Travel Time Scenario Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	0.107	0.175	0.377	1	0.539	1.113	0.790	1.568
Access mode(1)	*-0.533*	*0.178*	*8.932*	*1*	*0.003*	*0.587*	*0.414*	*0.832*
Age	*-0.507*	*0.100*	*25.801*	*1*	*0.000*	*0.602*	*0.495*	*0.733*
Job	0.123	0.093	1.758	1	0.185	1.131	0.943	1.356
Income	0.180	0.119	2.302	1	0.129	1.198	0.949	1.512
License(1)	*0.633*	*0.205*	*9.591*	*1*	*0.002*	*1.884*	*1.262*	*2.813*

'Table 4.16, continued'

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Vehicle availability	0.253	0.265	0.911	1	0.340	1.288	0.766	2.164
Education	*-0.320*	*0.129*	*6.161*	*1*	*0.013*	*0.726*	*0.564*	*0.935*
Travel purpose(1)	0.445	0.317	1.977	1	0.160	1.561	0.839	2.904
No. of trips per week	-0.003	0.110	0.001	1	0.978	0.997	0.804	1.236
Travel time increment	*0.186*	*0.010*	*323.693*	*1*	*0.000*	*1.205*	*1.181*	*1.230*
Constant	-2.586	1.233	4.402	1	0.036	0.075	0.790	1.568
Summary of statistics (-2) log likelihood Model chi-square Cox & Snell R^2 Nagelkerke R^2 Number of observations	 902.743 726.675 0.447 0.608 245							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. From Table 4.16, the travel time coefficient, *B* was positive, which implied that the increased in travel time from home to rail station was likely to increase the probability of frequent rail users shifting to private transport mode choice. It is interesting to note that frequent rail users who were using motorized access modes from home to rail station were less likely to shift to private transport mode than frequent rail users who were walking to rail station with respect to travel time increment. For the age factor, elderly commuters were less likely to shift to private transport mode than younger rail users. In other words, the elderly were more likely to travel with rail transit although the travel time was increased. In this study, about 5.3% of the respondents were aged 51 and above. The findings of the current study was consistent with Kamba et al. (2007) which found that elderly commuters were more likely to shift to bus and train compared to car with respect to travel time and travel cost increment. However, instead of travel cost, travel time and public transport fare either by rail or by bus, convenience and friendly facilities design should be taken into consideration in order to sufficiently cater public transportation services to all age groups. However, the findings of the current study contradicted with study by Gebeyehu and Takano (2007) who found that the probability of choosing bus decreases when age increases because elderly commuters tend to believe that travelling by bus was a costly mode choice. Gebeyehu and Takano (2007) also discovered that the bus conditions and technical policies were unfavourable in encouraging elderly commuters to travel by bus.

As expected, frequent rail users with driving license were 1.9 times more likely to shift to private transport mode than frequent rail users without driving license if travel time is about to increase. About 72.2% of the frequent rail users have driving license and all of them have a vehicle as alternative mode. Therefore, any increment in their overall travel time may influence their decision in the future. For educational factor, as level of education increased, frequent rail users were less likely to shift to private transport mode. In other words, they were more likely to travel consistently with rail transit rather than shifting to private transport mode.

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.17 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.28 and 4.29.

Table 4.17: Hosmer and Lemeshow's Test for Travel Time Increment Scenario

		Rail transit		Private transport		Total
		Observed	Expected	Observed	Expected	
Step 1	1	115	111.507	8	11.493	123
	2	108	102.119	15	20.881	123
	3	91	92.282	33	31.718	124
	4	70	75.628	53	47.372	123
	5	37	43.980	87	80.020	124
	6	23	24.807	100	98.193	123
	7	14	9.749	109	113.251	123
	8	4	4.643	119	118.357	123
	9	5	1.619	119	122.381	124
	10	0	.666	115	114.334	115
	Chi-square		df		Sig.	
	16.133		8		0.041	

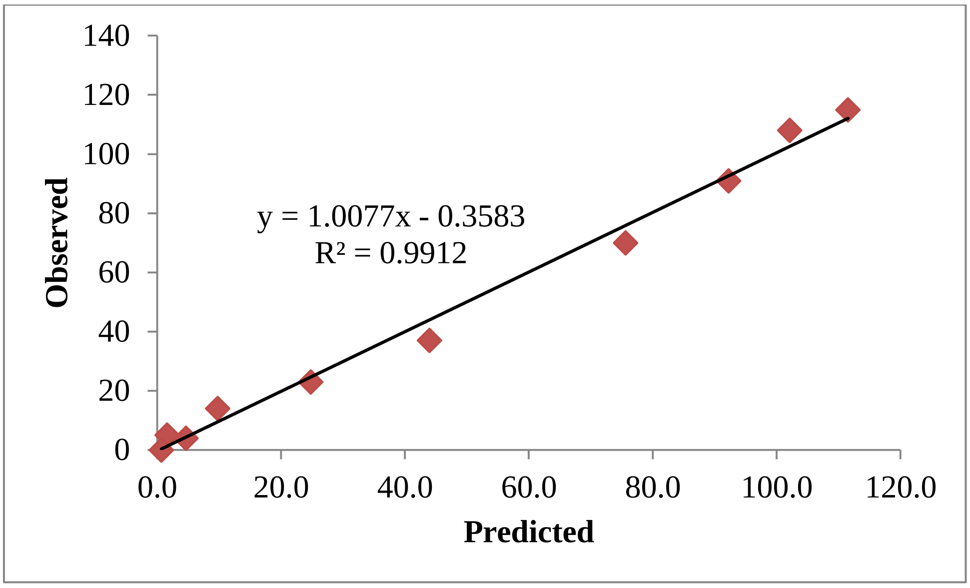

Figure 4.28: Predicted versus Observed Values by Rail Transit with Respect to Travel Time Increment

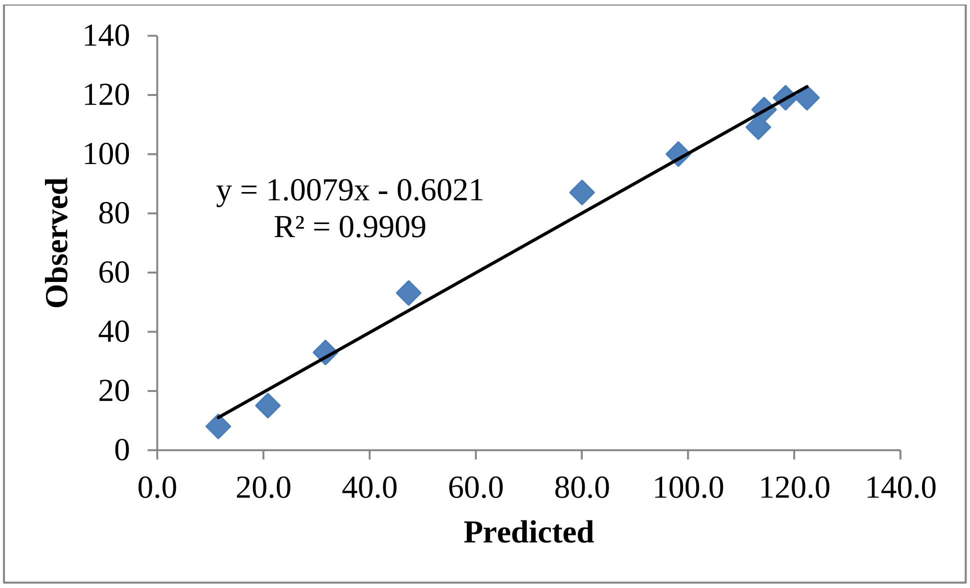

Figure 4.29: Predicted versus Observed Values by Private Transport with Respect to Travel Time Increment

The Chi-square value for the Hosmer-Lemeshow Test is 16.133, with significance level of less than 0.05, which indicating a poor fit. A significant Hosmer-Lemeshow test does not necessarily mean that predictive models are not useful. The significant Hosmer-Lemeshow test statistic is due to large sample size (Marcin and Romano, 2007). However, the R-squared value in Figure 4.24 and 4.25 was closer to 1.0, which indicate the better fit of regression line. In another words, the closer R-squared value to 1.0, the closer the line passes through all of the points.

The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to travel time increment, the full model containing all predictors was statistically significant, χ^2 (11, N = 245) = 725.675, $p < 0.05$, indicating that the model was able to distinguish between frequent rail users who will travel consistently by rail and who will shift to private transport. The model as a whole explained between 44.7% (Cox & Snell R squared) and 60.8% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 82.4% of the rail transit cases and 85.5% of the private transport cases. In overall, the prediction was correctly classified 84.3% of cases, an improvement over the 61.9% in Block 0 (model without any of independent variables).

4.8.2.10 The Probability of Shifting to Private Transport With Respect To Travel Time Increment

The mode share probabilities of private transport mode with respect to travel cost increment is exhibited in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.30. The probability of shifting to private transport is compared to rail transit mode choice (reference category). Based on Table 4.16, the binary logit equation for shifting probability to private transport mode with respect to travel time increment is listed as below;

$$P = \frac{\text{EXP}\,(-2.586 + (0.107 * \text{Gender}) - (0.533 * \text{Access Mode}) - (0.507 * \text{Age}) - (0.123 * \text{Job}) + (0.180 * \text{Income}) + (0.633 * \text{License}) + (0.253 * \text{Vehicle Availability}) - (0.320 * \text{Education}) + (0.445 * \text{Travel Purpose}) - (0.003 * \text{Number of trip}) + (0.186 * \text{Travel Time Increment}))}{(1 + \text{EXP}\,(-2.586 + (0.107 * \text{Gender}) - (0.533 * \text{Access Mode}) - (0.507 * \text{Age}) - (0.123 * \text{Job}) + (0.180 * \text{Income}) + (0.633 * \text{License}) + (0.253 * \text{Vehicle Availability}) - (0.320 * \text{Education}) + (0.445 * \text{Travel Purpose}) - (0.003 * \text{Number of trip}) + (0.186 * \text{Travel Time Increment})))}$$

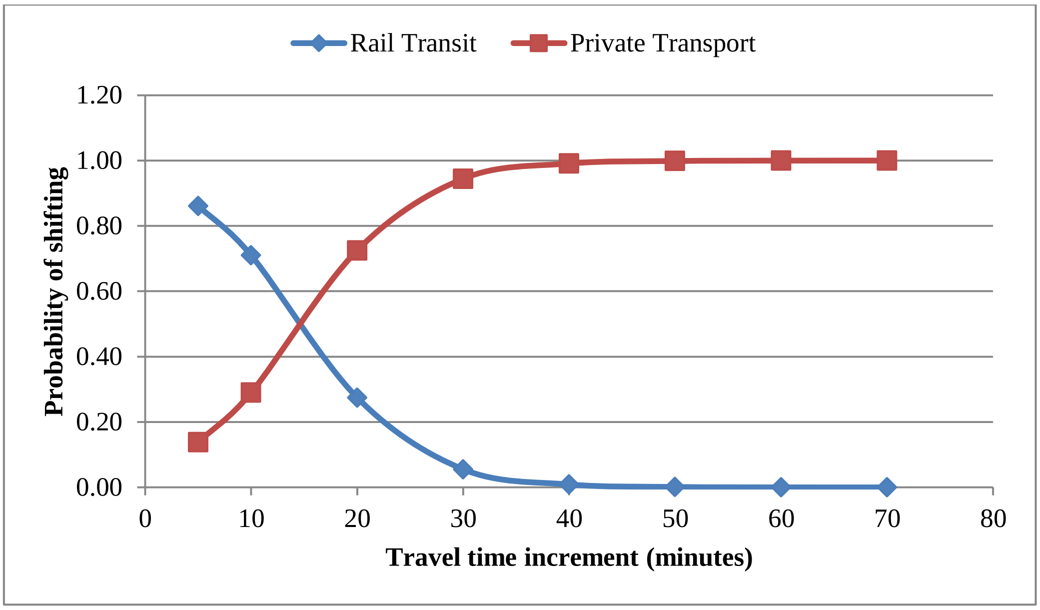

Figure 4.30: Probability of Shifting to Private Transport With Respect To Travel Time Increment

As depicted in Figure 4.30, It was discovered that the likelihood of shifting to private transport was increased from 14.0% to 100.0% by 5 minutes until 60 minutes increment from their current travel time. At the same time, the probability of using rail transit was decreased from 86.0% to 0.0% by 5 minutes until 60 minutes increment from their current travel time. Based on previous finding, the current average travel time by rail was about 91 minutes (including the return trip) by taking various access modes. By using current average travel time as consideration, it can be proposed that the frequent rail users will completely shift to private transport mode if their current travel time was 151 minutes (91minutes + 60 minutes). In addition, when travel time was increased of 20 minutes from their current travel time, shifting probability to private transport showed huge inclination which was about 73%, meanwhile rail transit probability decreased to 27.0%. The shifting probability to private transport was continuosly inclined to 94.0% when the current travel time of frequent rail users was increased to 30 minutes from their current travel time. A 50:50 split of either shifting to private transport or using rail transit was attained when the current average travel time was increased to15 minutes. Based on current travel time value, a 50:50 split would be at 106 minutes (91 + 15 minutes), which was nearly 2 hours. This optimum value could be suggested a significant value of frequent rail user before their shifting to private transport, which satisfy their requirement in terms of travel time.

In accordance to Urban Rail Development Plan for Greater Kuala Lumpur Klang Valley (GKL/KV) 2013, (Land Public Transport Commission, 2013b), the desired travel time for rail travellers to reach Kuala Lumpur (Malaysia's capital) are within 75 minutes. By comparing with current data, it was discovered that only 31.8% of frequent rail users travelled within 75 minutes to reach their final destination and also for the return journey. Subsequently, in this study about 53.5% of frequent rail users travelled below average current travel time, which was 91.0 minutes. In other words, majority of current frequent rail users were facing and struggling with their daily travel time from origin to their destination (including the return journey). One of the issues which was related to travel time is excessive number of transfers before reaching their destination. The root cause to these problems which has been identified by Land Public Transport Commission (2013) was because of minimal public transport coverage in certain areas and lack of integration between modes.

4.8.2.11 Scenario 6: Rail Frequency Decrement

The frequent rail users' likelihood to shift to private transport under sequence decrement of rail frequency scenarios was discussed. A summary of the estimations from the model with respect to rail frequency decrement was tabulated in Table 4.18. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the frequent rail users who will shift to private transport if the access cost is about to increase and value 0 for those which will not shift to private transport and travel consistently with rail transit. The study found that out of the 11 predictor variables entered in the analysis, only three predictor variables were found to be significant at least at the 0.05 level. The significant predictor variables were access mode, license availability and rail frequency decrement.

Table 4.18: Estimations from the Binary Mode Choice Model for Rail Frequency Decrement Scenario

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	0.067	0.162	0.173	1	0.678	1.070	0.779	1.469
Access mode(1)	-0.605	0.166	13.253	1	0.000	0.546	0.394	0.756
Age	-0.116	0.088	1.756	1	0.185	0.890	0.750	1.057
Job	0-.113	0.086	1.714	1	0.190	0.893	0.755	1.058
Income	0.079	0.110	0.511	1	0.475	1.082	0.872	1.342
License(1)	0.406	0.187	4.693	1	0.030	1.501	1.039	2.167
Vehicle availability	-0.104	0.244	0.183	1	0.669	0.901	0.559	1.453
Education	0.217	0.119	3.312	1	0.069	1.243	0.983	1.570
Travel purpose(1)	-0.160	0.293	0.297	1	0.586	0.852	0.480	1.514
No. of trips per week	0.076	0.102	0.556	1	0.456	1.079	0.884	1.318
Rail frequency decrement	-1.316	0.074	314.780	1	0.000	0.268	0.232	0.310
Constant	7.041	1.201	34.344	1	0.000	1142.844		
Summary of statistics								
(-2) log likelihood	1034.040							
Model chi-square	563.350							
Cox & Snell R^2	0.369							
Nagelkerke R^2	0.506							
Number of observations	245							

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. In this study, the influence of rail frequency decrement on travel mode choice preference was investigated. The rail frequency was assumed as eight times per hour. The hypothetical stated preference scenario design for rail frequency was designed by decreasing the assumed current frequency, namely 8 times until 3 times per hour.

Contrary to expectation, the frequent rail users were less likely to shift to private transport mode by rail frequency decrement. The odds ratio tell us that as the rail frequency decreased by a unit, the change in the odds of shifting to private transport mode compared to rail transit is 0.268. The frequent rail users were 3.7 times more likely to use rail transit if rail frequency is about to increase. There are several explanations for this result. In the stated preference scenario design, the rail frequency was decreased from 8 times per hour (7.5 minutes headway) to 3 times per hour. The low preference among frequent rail users to shift to private transport is probably due to inertia effects (Meloni et al., 2013; Cantillo & Ortuzar, 2007; Cherchi & Manca, 2011). Inertia effect is the effect that the past experiences may have had on the present choice and it was referred to the tendency to maintain with the past choice even when another choice becomes more attractive. The result of this study has pointed out that past behaviour is a strong predictor of future behaviour (Meloni et al., 2013; Cherchi, 2009; Garling & Axhausen, 2003). However, further explanation on the relationship will be discussed in the probability prediction analysis latter.

For this analysis, frequent rail users who walk to rail station were set as a reference group (coded as 0) in the access mode variable. It was discovered that frequent rail users who used motorized access modes were less likely to shift to private transport if current assumption of rail frequency is hypothetically decreased. In other words, the frequent rail users who accessed rail transit by walking were 1.8 times more likely to shift to private transport mode. It was also discovered that frequent rail users, which have driving license, were 1.5 times more likely to shift to private transport than frequent rail users without driving license by rail frequency decrement. The Hosmer and Lemeshow's Goodness-of-

Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.19 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.31 and 4.32.

Table 4.19: Hosmer and Lemeshow's Test for Rail Frequency Decrement Scenario

		Rail transit		Private transport		
		Observed	Expected	Observed	Expected	Total
Step 1	1	111	107.203	12	15.797	123
	2	101	96.550	22	26.450	123
	3	69	78.838	54	44.162	123
	4	61	61.028	62	61.972	123
	5	37	39.980	86	83.020	123
	6	29	25.821	94	97.179	123
	7	14	14.095	109	108.905	123
	8	5	8.184	118	114.816	123
	9	9	4.117	114	118.883	123
	10	2	2.183	116	115.817	118
	Chi-square		df		Sig.	
	13.582		8		0.093	

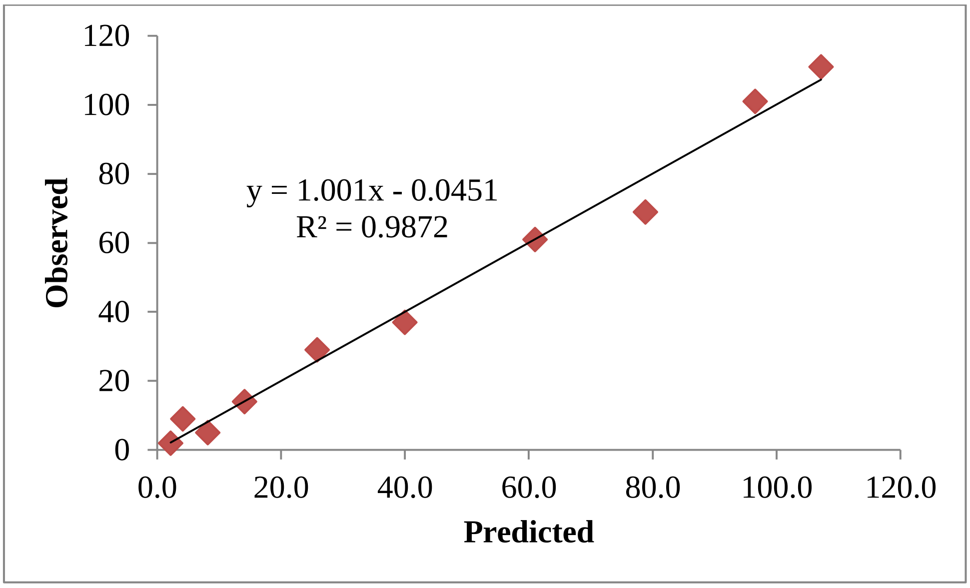

Figure 4.31: Predicted versus Observed Values by Rail Transit with Respect to Rail Frequency Decrement

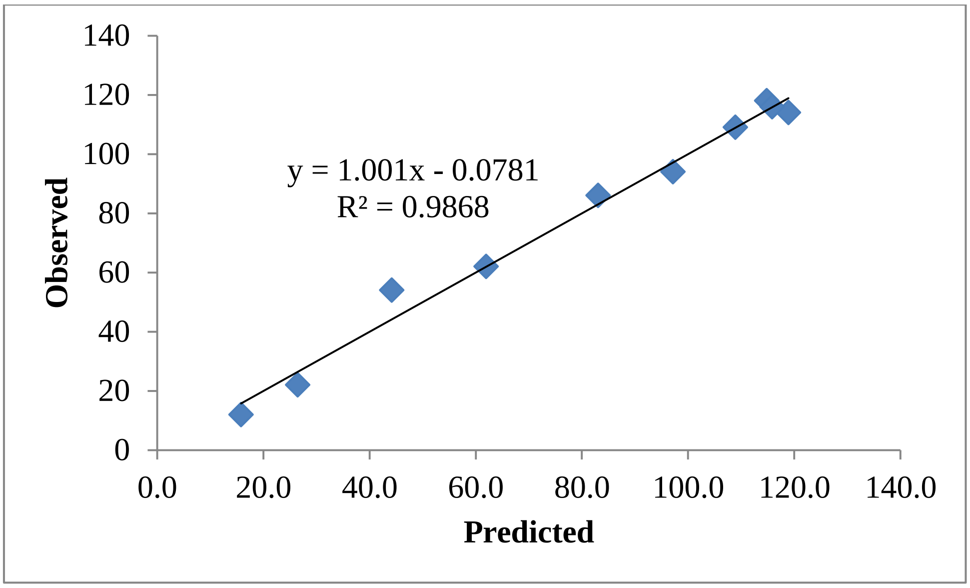

Figure 4.32: Predicted versus Observed Values by Private Transport with Respect to Rail Frequency Decrement

Based on Figure 4.31 and 4.32, there was a slight difference between the observed and predicted values for both modes of transport. The Chi-square value was 13.582 with a significance level of 0.093. This value is larger than 0.05, therefore indicated support for the model. In addition, the log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to rail frequency decrement, the full model containing all predictors was statistically significant, χ^2 (11, N = 245) = 1034.040, $p < 0.05$, indicating that the model was able to distinguish between frequent rail users who will travel consistently by rail and who will shift to private transport. The model as a whole explained between 36.9% (Cox & Snell R squared) and 50.6% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 71.5% of the rail transit cases and 85.3% of the private transport cases. In overall, the prediction was correctly classified 80.3% of cases, an improvement over the 64.2% in Block 0 (model without any of independent variables).

4.8.2.12 The Probability of Shifting with Respect to Rail Frequency Decrement

The mode share probability of private transport mode with respect to rail is exhibited in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.33. The probability of shifting to private transport mode is compared to rail transit mode choice (reference category). Based on Table 4.18, the binary logit equation for shifting probability to private transport mode with respect to rail frequency decrement is listed as below;

$$P = \frac{\begin{array}{c}\text{EXP (7.041 + (0.067*Gender) - (0.605*Access Mode) - (0.116*Age) - (0.113*Job)} \\ \text{+ (0.079*Income) + (0.406*License) - (0.104*Vehicle Availability) + (0.217*Education)} \\ \text{- (0.160*Travel Purpose)+(0.076*Number of trip) - (1.316*Rail Frequency Decrement))}\end{array}}{\begin{array}{c}\text{(1 + EXP (7.041 + (0.067*Gender) - (0.605*Access Mode) - (0.116*Age) - (0.113*Job)} \\ \text{+ (0.079*Income) + (0.406*License) - (0.104*Vehicle Availability) + (0.217*Education)} \\ \text{- (0.160*Travel Purpose)+(0.076*Number of trip) - (1.316*Rail Frequency Decrement))).}\end{array}}$$

It was previously mentioned in questionnaire design that the current rail frequency was assumed as 8 times per hour (7.5 minutes interval for each rail transit arrival). In the analysis, the assumed rail frequency was decreased from 7 times until 3 times per hour. It was discovered that the likelihood of shifting to private transport increased from 17.0% to 97.0% when the rail frequency was decreased from 7 times until 3 times per hour. Simultaneously, the probability of using rail transit showed a reduction from 83.0% to 3.0% by rail frequency decrement.

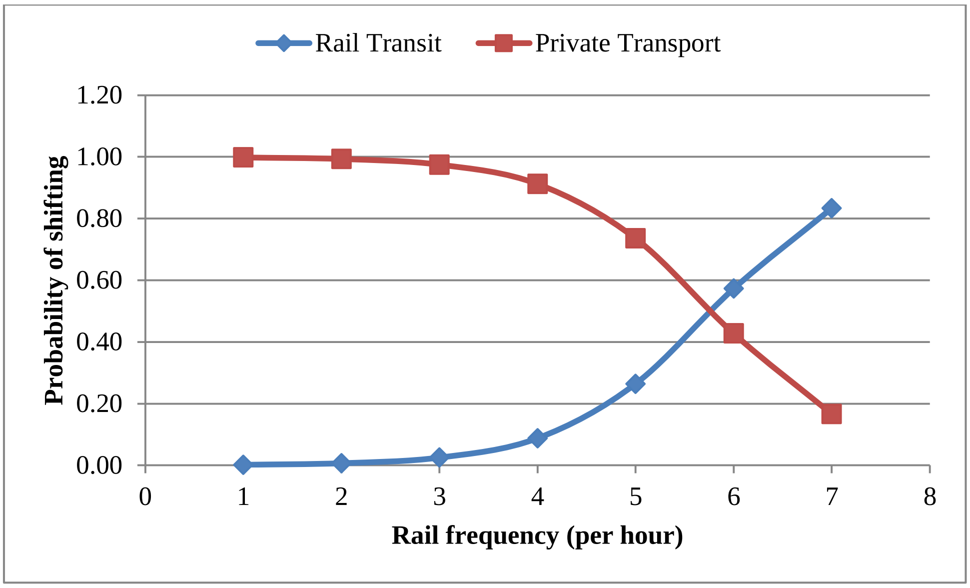

Figure 4.33: Probability of Shifting to Private Transport With Respect To Rail Frequency Decrement

For the purpose of this study, interpolations of shifting probability with respect to rail frequency decrement from 3 times until one time per hour were also simulated. The shifting probability to private transport mode was 100.0% more likely to happen if current rail frequency was decreased to one time per hour. In relation to current condition, the rail transit frequencies in Klang Valley were varied due to route coverage area and rail system capabilities. In the scope of this study, the highest rail headway was recorded at 3 minutes per hour (about 20 times per hour) during peak period. This service was provided by Light Rail Transit (LRT) system of Kelana Jaya Line. The lowest rail headway was recorded at 15 minutes per hour (about 4 times per hour) during peak period. This service was provided by KTM Komuter system of Rawang-Seremban Line and Port Klang-Batu Caves Line. It was discovered that current rail travellers are dissatisfied with KTM Komuter services and it was identified that 12 out of 50 KTM Komuter stations are suffered with low ridership, which was less than 250 passengers per day (Land Public Transport Commission, 2013). It was indicated that the inaccessibility from surrounding areas as well as the low frequency and slow journey times on KTM Komuter were the determinant factors (Performance Management Unit and Delivery Unit, 2014; Land Public Transport Commission, 2013). Therefore, it is important to realize on how influential the rail regularity to frequent rail users. In this study, it was inferred that the lowest acceptable rail frequency is 4 times per hour. This value was suggested based on current rail frequency services and shifting probability finding in the scope of this study.

4.8.3 Influence of Travel Time against Travel Cost

Another key point that could be interesting to discuss is the influence of travel time against travel cost. The influence of travel time and travel cost on probability of shifting to private transport mode was plotted in Figure 4.34 below. The travel time increment in x-axis was presented as percentage and was calculated based on current average travel time (91 minutes) plus hypothetical travel time value increment from 5 minutes until 70 minutes (96 minutes until 161 minutes). After the conversion to percentage, the travel time increments were plotted from 5.0% to 77.0%.

As depicted in Figure 4.34, it was suggested that frequent rail users were more affected by travel time increment rather than travel cost increment. It can be seen that with 16% (15 minutes) increment from current travel time (91 minutes), a 50:50 split of either shifting to private transport or using rail transit was attained at 106 minutes. However, the frequent rail users were consistently travelled with rail transit despite the 16% (RM1.20) increment from their current travel cost (RM7.60). In addition, it was discovered that frequent rail users will only be shifted to private transport mode at 55% increment of their current travel time. As a comparison, it was found that frequent rail users were consistently travelled with rail transit at 55% increment from their current travel cost.

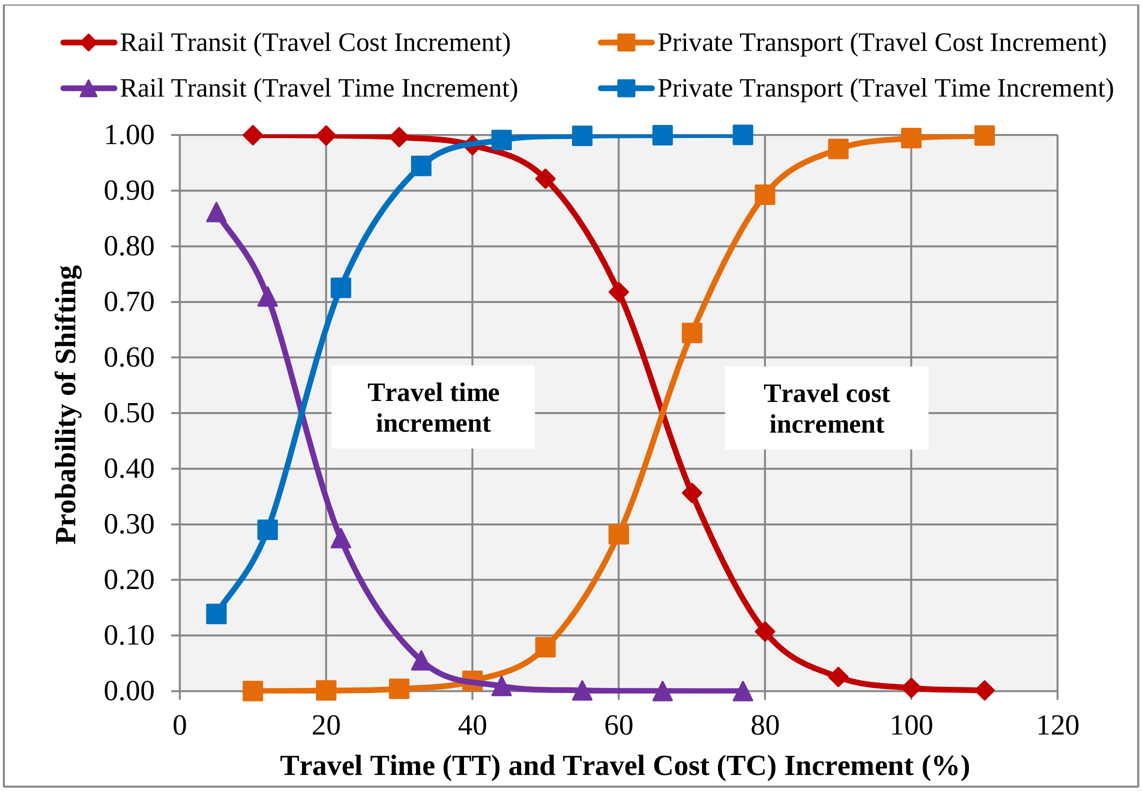

Figure 4.34: Influence of Travel Time versus Travel Cost on Private Transport Mode Choice Probability

From these findings, it can be inferred that frequent rail users were willing to tolerate more on travel cost rather than travel time increment. Therefore, travel time is the most determinant indicator as compared to travel cost, which will influence the travel mode choice preference among frequent rail users. From the finding, relevant policies could be implemented by the policy makers in order to ensure commuters travelled consistently using rail transit. The related policies, which related to travel time were included access time from home to station, waiting time at the station, in-vehicle time and egress time from station to final destination. The improvement on these attributes will encourage more travellers to choose rail transit as their main travel mode choice. The waiting time at station is related to time headway for each rail transit to reach the station. To minimize waiting time at station, regular and frequent services of rail transit need to be guaranteed. This is supported by Dell'Olio et al. (2011), which stated that increment in modal split could be achieved by improving journey and waiting time. The study by Beirao and Cabral (2007) pointed out that travel time and reliability play a key role when choosing a mode of transport for work journeys. This is because the commuters want to feel in control when waiting for bus or LRT. In addition, Beirao and Cabral (2007) also highlighted commuter's preference to use direct frequent public transport service and reluctantly to do the interchange between rail stations or change vehicles during their journey.

One of the underlying factors associated with rail travel attributes is by improving the current access modes from home to rail station. Walking from home to rail station is found to be a dominant access mode within an access distance of less than 1000 meters. Meanwhile, using bus from home to rail station is the highly preferable option when the access distance is more than 2000 meters. One of the policies that can be implemented is the use of green access modes such as walking, bicycle and bus as compared to the motorized access modes i.e. car, motorcycle and taxi. Houston et al. (2014) found that households within 0.8km of a rail transit station are more likely to walk to rail station and simultaneously contributed to higher rail transit trips. The possibility to walk less than 1000 meters from home to rail station can be achieved by providing better pedestrian facilities along the way to station. The improvements might include providing convenient walking path, sheltered walkways, proper facilities for disabled and direct pedestrian connectivity to rail station. In order to improve bus services for access distance of more than 2km, congestion problem on the roads in the rail station area should be eliminated. Additionally, providing exclusive bus lanes from residential areas to workplace zone is also one of the possibilities that could be implemented. These initiatives are also supported by Redman et al. (2013), which stated that one of the public transport attributes that attracts car users was the improvement on accessibility to public transportation services. Furthermore, Hamre and Buehler (2014) also identified that by providing vanpooling services and trip-end facilities at workplace, commuters tend to travel more with public transport to work.

It was discovered that all of the respondents (frequent rail users) had cars available for the journey, but still choose the option to travel by rail. The finding showed that more than one quarter of the frequent users are not the 'captive' rider and may use their private transport for their journey but they preferred to travel by rail. However, only 22.2% of the frequent rail users that has the cars available use them to access the station. Whereas, about 44.9% of them walked to the station. The study by Givoni and Rietveld (2007) and Marten (2004) found that the availability of cars did not have a strong effect on the choice of access mode to the station and availability of cars did not necessarily mean the railway is not the preferred choice of mode to reach the workplace. One of the drawbacks in the past strategies to promote rail transit usage is because the local authority had not provided sufficient park-and-ride facilities for private car commuters (Mohamad & Kiggundu, 2007). Due to an increasing number of the car registered in Klang Valley, Malaysia, the vehicle availability is possibly one of the significant factors in encouraging more rail transit usage. In corresponding to this study, it was suggested that the frequent rail users with available private vehicles will continue using rail transit instead of shifting to private transport by using their private transport as access mode to rail transit station. Hamid et al. (2007, 2011) stated that the trip makers perceived the rail commuter system and its park-and-ride facilities as a better alternative form of transportation than travelling by private vehicles from the suburbs to city centre.

4.8.4 Model Estimation Results for Private Transport Users Analysis

In this section, the results estimated the Binomial Logistic Regression (BNL) models which discuss the travel behaviour change, (i.e. the likelihood to shift to rail transit mode) as well as the likelihood of private transport users to consistently travel with private transport despite increment in their daily travel attributes. In this analysis, the interaction of each attribute in a utility function of a mode is presented by its regression coefficients, B, and were estimated using maximum likelihood methods. The positive values of the regression coefficients imply a positive impact while negative values imply a negative impact on the utility function. In this analysis, the number of samples used in the analysis were from 234 respondents which travelled daily by private transport. In this analysis, the dependent choice variable represents the probability of shifting to rail transit for daily trip. The variable was coded 1 if the private transport users consider to shift to rail transit, and 0 if the private transport users consistently travel with their owns' vehicle for daily trip. In addition, private transport mode was set as reference category. The explanatory or independent variables included in the analysis were gender, access mode, age, job, income, driving license, vehicle availability, educational level, travel purpose, number of trip and various hypothetical travel attributes scenarios. The coding of each explanatoy variable was tabulated in Table 4.6. The summary of model estimation results using Binomial Logistic Regression (BNL) analysis with respect to different hypothetical travel attributes scenarios are presented in the following subsections.

4.8.4.1 Scenario 1: Fuel Price Decrement

A summary of the estimations from the model were presented in Table 4.20. The maximum likelihood estimates of the constant and predictor variables are presented under the column heading Estimated Coefficient, B. The parameter estimates in this table provide the clues on how the predictors contributed to the probability of shifting to rail with respect to fuel price decrement. The standard errors of the B estimates are given under the column SE and the squared ratios of the estimates to their respective standard errors are given under the column Wald in the same table. The observed significance levels of the tests (i.e. the p = values) are given under the column Sig. As previously mentioned, the dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the fuel price is about to increase and value 0 for those which will not shift to rail transit and travel consistently with private transport. A value of odds ratio, Exp(B) < 1 corresponds to a decrease in the odds of the dependent variable while a value of odds ratio, Exp(B) > 1 means the variable is more independent to the dependent variable. The objective was to investigate whether a set of predictor variables comprising socio-demographic characteristics such as gender, age, job, income, license, vehicle availability, educational levels, travel purpose, number of trips and fuel price decrement could be used to predict the probability of shifting to private transport. The study found that out of the 11 predictor variables entered in the analysis, four predictor variables were found to be significant at least at the 0.05 level.

Table 4.20: Estimations from the Binary Mode Choice Model for Fuel Price Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	0.283	0.150	3.586	1	0.058	1.328	0.990	1.780
Access Mode(1)	*1.192*	*0.253*	*22.171*	*1*	*0.000*	*3.294*	*2.006*	*5.411*
Age	-0.099	0.064	2.378	1	0.123	0.905	0.798	1.027
Job	-0.074	0.073	1.036	1	0.309	0.928	0.805	1.071
Income	*0.181*	*0.069*	*6.857*	*1*	*0.009*	*1.199*	*1.047*	*1.372*
License(1)	-0.364	0.248	2.155	1	0.142	0.695	0.428	1.130

‘Table 4.20, continued’

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Vehicle availability	*0.442*	*0.188*	*5.503*	*1*	*0.019*	*1.556*	*1.075*	*2.252*
Education	0.098	0.112	0.775	1	0.379	1.103	0.886	1.374
Travel purpose(1)	-0.672	0.365	3.380	1	0.066	0.511	0.250	1.045
No. of trips per week	-0.033	0.079	0.179	1	0.672	0.967	0.829	1.128
Fuel price increment	*0.062*	*0.005*	*167.899*	*1*	*0.000*	*1.064*	*1.054*	*1.074*
Constant	*-4.855*	*1.041*	*21.740*	*1*	*0.000*	*0.008*		
Summary of statistics								
(-2) log likelihood	*1239.133*							
Model chi-square	*280.164*							
Cox & Snell R^2	*0.181*							
Nagelkerke R^2	*0.274*							
Number of observations	*234*							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as the reference. The positive sign of fuel price increment indicated that the increase in fuel price from home to rail station was likely to increase the probability of private transport users shifting to rail transit mode. It was found that the private transport users who used motorized access mode were 3.3 times more likely to shift to rail transit as compared to those who walked to reach rail station from home. The increment of fuel price will indirectly influence the bus and taxi fare as well as expenses on fuel consumption if the private transport is used as access mode to reach rail station.

It can be said that fuel price increment was also highly related to access cost increment as it will directly affect the overall travel cost for the trips. In addition, 93.8% of private transport users who used motorized access mode spent below RM4.00 for their access cost. Therefore, any fuel price increment will highly influence the private transport users to consider travel with rail transit. It is interesting to note that private transport with higher monthly income were more sensitive towards fuel price increment.

The odds ratio of this variable was 1.2, which indicated that as fuel price increased, private transport users were more likely to shift to rail transit mode. This can be explained by the fact that in the current study, about 68.8% of private transport users with monthly income of less than RM3000 used their private transport as daily travel mode. It was discovered that private transport users with more vehicles were more likely to shift to rail transit as compared to those who has fewer vehicles. This finding also confirmed the expectation that any increment in driving cost particularly the fuel price, will become a strong deterrent to private transport users because any fuel price increment will directly influence the overall travel cost of private transport users. However, based on econometric model by Kain and Liu, (1996), the transit use will increase less if the rail fare was increased rather than rail service improvement although both approaches will reduce the private car use. Another possible explanation for this might be that private transport users will use their vehicles as access mode to rail station rather than travel directly from home to their workplace if the fuel price is about to increase. It was also discovered that gender also showed significant relationship at 0.10 levels. Females were more likely to shift to rail transit as compared to males if fuel price is about to increase. From cross-tabulation, it was found that monthly income of females' users was 14.5% lower than males and this probably one of the factors, which will encourage females to shift to rail transit as compared to males. The purpose of travel had a statistically significant contribution to the explanation of frequent rail users shifting behaviour at 0.10

levels. It was discovered that private transport users who used their vehicles because of other trip purposes rather than work trips were less likely to shift to rail transit by fuel price increment. This is probably because of their concerns on travel behaviour and cost parameter. This finding is supported by Meloni et al., (2013), which found that individuals who depended on car usage as their daily travel mode are difficult to be shifted (inertia effect). In addition, about 44.9% of private transport users travelled more in distance (> than 30km). It was highlighted and supported by Meloni et al. (2013), which discovered that individuals who travel more than 25k kilometres each year are less likely to change their travel mode behaviour.

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.21 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.16 and 4.17. This test was carried out in order to assess how well the model fitted the data and was recognized as the most reliable test of model fit in SPSS (Pallant, 2007).

Table 4.21: Hosmer and Lemeshow's Test for Fuel Price Increment Scenario

		Private transport		Rail transit		Total
		Observed	Expected	Observed	Expected	
Step 1	1	137	136.597	3	3.403	140
	2	133	132.962	7	7.038	140
	3	129	129.448	11	10.552	140
	4	125	125.324	15	14.676	140
	5	117	119.555	23	20.445	140
	6	116	111.876	24	28.124	140
	7	102	102.505	38	37.495	140
	8	90	89.825	50	50.175	140
	9	72	74.959	68	65.041	140
	10	58	55.948	86	88.052	144
	Chi-square		df		Sig.	
	1.593		8		0.991	

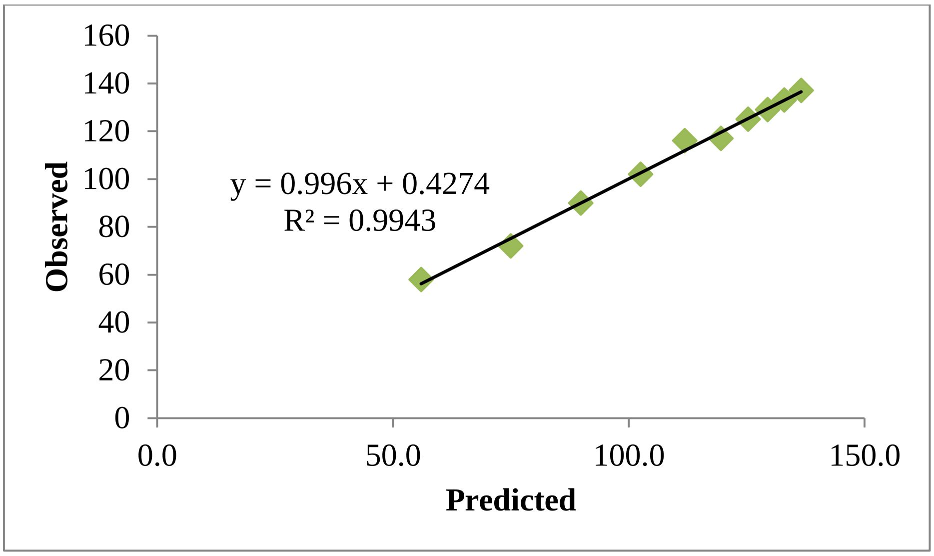

Figure 4.35: Predicted versus Observed Values by Private Transport with Respect to Fuel Price Increment

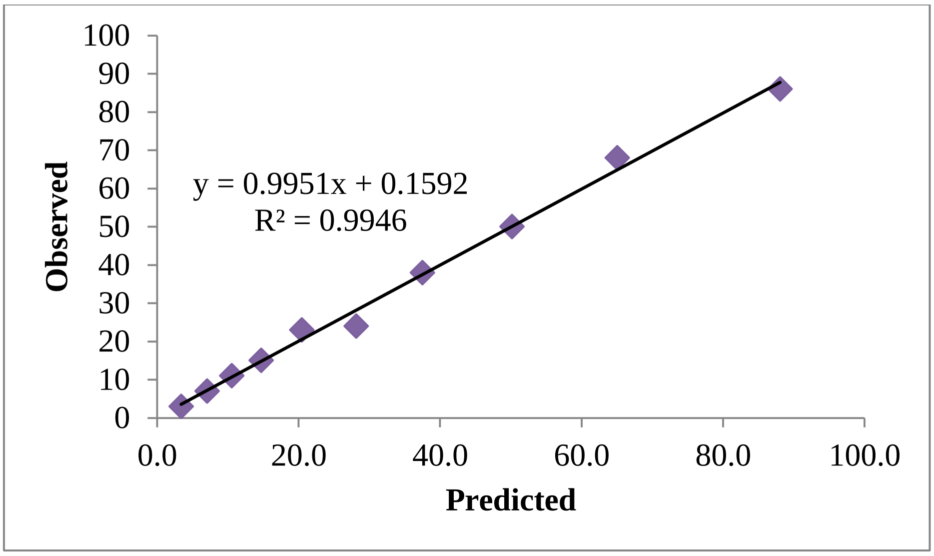

Figure 4.36: Predicted versus Observed Values by Rail Transit with Respect to Fuel Price Increment

Based on Table 4.9, Figure 4.16 and Figure 4.17, it was discovered that there was a minor difference between the observed and predicted values for both modes of transport as evidenced by the Chi-square value with a significance level of 0.991. This value is larger than 0.05, which indicated good fit and support the model. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to fuel price increment, the model with all predictors as in Table 4.20 containing was statistically significant, χ^2 (11, N = 234) = 280.164, $p < 0.05$, indicating that the model was able to distinguish between respondents who will be shifted and who will not be shifted to rail transit. The model as a whole explained between 18.1% (Cox & Snell R squared) and 27.4% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 93.5% of the private transport cases and 32.9% of the rail transit cases. In overall, the prediction was correctly classified 79.5% of cases, an improvement over the 76.9% in Block 0 (model without any of independent variables).

4.8.4.2 The Probability of Shifting with Respect to Fuel Price Increment

The mode share probabilities was calculated by solving the binary logit equation for probability using a range of fuel price increment while keeping the other variables constant (according to the mean values). The probability of shifting to rail transit mode is compared to private transport mode (reference category). Based on Table 4.20, the binary logit equation for shifting probability to rail transit mode with respect to fuel price increment is listed as below;

$$P = \frac{\text{EXP}((-4.855 + (0.283*\text{Gender}) + (1.192*\text{Access Mode}) - (0.099*\text{Age}) - (0.074*\text{Job}) + (0.181*\text{Income}) - (0.364*\text{License}) + (0.442*\text{Vehicle Availability}) + (0.098*\text{Education}) - (0.672*\text{Travel Purpose}) - (0.033*\text{Number of trip}) + (0.062*\text{Fuel Price Increment}))}{(1 + \text{EXP}((-4.855 + (0.283*\text{Gender}) + (1.192*\text{Access Mode}) - (0.099*\text{Age}) - (0.074*\text{Job}) + (0.181*\text{Income}) - (0.364*\text{License}) + (0.442*\text{Vehicle Availability}) + (0.098*\text{Education}) - (0.672*\text{Travel Purpose}) - (0.033*\text{Number of trip}) + (0.062*\text{Fuel Price Increment})))}$$

The mode share probabilities of private transport and rail transit mode with respect to fuel price increment is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.37 below.

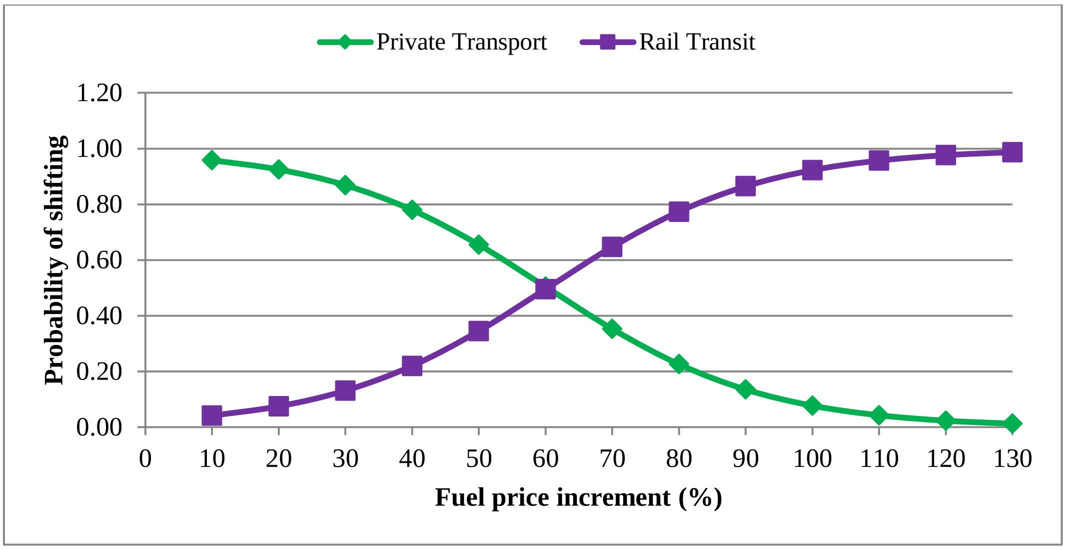

Figure 4.37: Probability of Shifting to Rail Transit Mode With Respect to Fuel Price Increment

The probability of shifting towards rail transit mode depicted stimulating tendency by increment of fuel price from 10% until 130%. The mode choice probabilities were 4.0% until 100.0% likelihood to rail transit with 10% until 130% increment from current fuel price. Simultaneously, probability of using private transport decreased from 96.0% until 0.0% likelihood when the current fuel price was increased from 10% until 100%. It was predicted that a 50:50 split might be achieved when the fuel price increment was set at 60%. It was suggested that 60% was the maximum fuel price increment that they were able to tolerate before the likelihood to change to rail transit gradually increased and likelihood to travel with private transport gradually decreased. Based on the current situation in Malaysia, the fuel prices were varied every month since the end of 2014. The current fuel prices for each month will be floated according to international price. From January until September 2016, the fuel price for RON95 petrol was in the range of RM1.60 (minimum) to RM1.85 (maximum) per litre. Based on the finding, a 100% shifting from private transport to rail transit was possible to achieve when the fuel prices was increased until 130% from its current price. Therefore, with respect to current flow of fuel price for RON95, a 100% shifting to rail transit will be achieved if the fuel price was increased in the range of RM3.70 (minimum) until RM4.30 (maximum) per litre. This finding can be proposed as an important indicator to implement a new policy or system because any increment in current fuel price will likely encourage more private transport users to shift to rail transit. In short, any fuel price increment in the future will strongly affect the daily travel mode of private transport.

4.8.4.3 Scenario 2: Travel Cost Increment

A summary of the estimations from the model with respect to travel cost increment was presented in Table 4.22. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the travel cost is about to increase and value 0 for those which will not shift to rail transit and travel consistently with private transport. The study found that out of the 11 predictor variables entered in the analysis, two predictor variables were found to be significant at least at the 0.05 level.

Table 4.22: Estimations from the Binary Mode Choice Model for Travel Cost Scenario Increment

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	*-.352*	*.148*	*5.676*	*1*	*.017*	*.704*	*.527*	*.940*
Access mode(1)	.354	.198	3.193	1	.074	1.424	.966	2.100
Age	.085	.058	2.108	1	.147	1.088	.971	1.220
Job	-.089	.071	1.565	1	.211	.915	.796	1.052

‘Table 4.22, continued’

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Income	.018	.069	.066	1	.798	1.018	.889	1.166
License(1)	-.032	.239	.017	1	.895	.969	.607	1.547
Vehicle availability	-.011	.199	.003	1	.956	.989	.670	1.460
Education	-.137	.106	1.664	1	.197	.872	.708	1.074
Travel purpose(1)	-.472	.335	1.987	1	.159	.624	.324	1.202
No. of trips per week	-.112	.076	2.199	1	.138	.894	.771	1.037
Travel cost increment	*.078*	*.005*	*253.790*	*1*	*.000*	*1.082*	*1.071*	*1.092*
Constant	-2.295	.975	5.539	1	.019	.101		
<u>*Summary of statistics*</u>								
(-2) log likelihood	*1301.275*							
Model chi-square	*371.014*							
Cox & Snell R^2	*0.232*							
Nagelkerke R^2	*0.334*							
Number of observations	*245*							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. The positive sign of travel cost indicated that an increase in travel cost from home to final destination was likely to increase the probability of private transport users shifting to rail transit mode. Therefore, the null hypothesis that the coefficients (B) is equal to zero for these independent variables was rejected. It was discovered that females were less likely to shift to rail transit as compared to males with respect to travel cost increment. This finding was contradicted with Kmanba (2008) study, which found that females were two times more likely to take the bus than driving compared to males. However, other predictor variables showed insignificant relationship with respect to travel cost increment. Therefore, it was suggested that private transport users were less sensitive to travel cost increment. They will continue to travel with their vehicle and would not consider shifting to rail transit despite of travel cost increment. Another possible explanation is that, the result appears to suggest a low preference among private transport users to shift travel mode due to inertia effects (Meloni, et al., 2013; Cantillo, et al., 2007; Cherchi & Manca, 2011). Inertia effect is referred to the tendency to maintain with the past choice even though another alternative offers more appealing scenario. The study by Meloni et al., (2013) found that individuals who depended on car usage as their daily travel mode are difficult to be shifted due to inertia effect. In this study, 44.9% of private transport users travelled more than 30 km for their daily trip. Meloni et al. (2013) highlighted that individuals who travel more than 25k kilometres each year are less likely to change their travel mode behaviour. The result of this study has pointed out that past behaviour is a strong predictor of future behaviour. The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.23 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.38 and 4.39.

Table 4.23: Hosmer and Lemeshow's Test for Travel Cost Increment Scenario

		Rail transit		Private transport		
		Observed	Expected	Observed	Expected	Total
Step 1	1	133	137.549	9	4.451	142
	2	132	132.925	8	7.075	140
	3	128	129.031	12	10.969	140
	4	127	123.962	14	17.038	141
	5	116	115.149	24	24.851	140
	6	110	104.338	31	36.662	141
	7	90	90.053	50	49.947	140
	8	82	74.202	58	65.798	140
	9	47	58.081	94	82.919	141
	10	42	41.708	97	97.292	139
	Chi-square		df		Sig.	
	12.207		8		0.142	

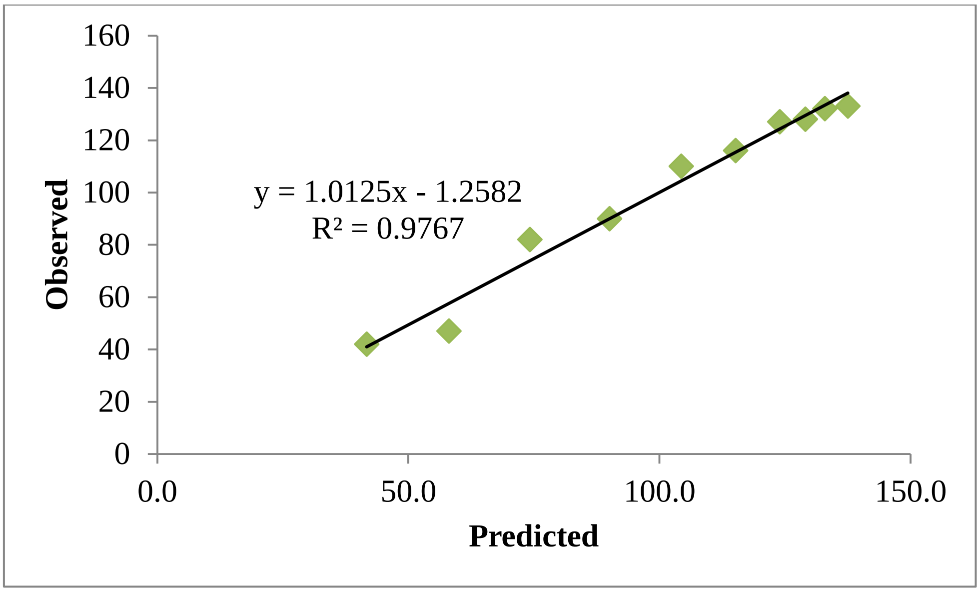

Figure 4.38: Predicted versus Observed Values by Private Transport with Respect to Travel Cost Increment

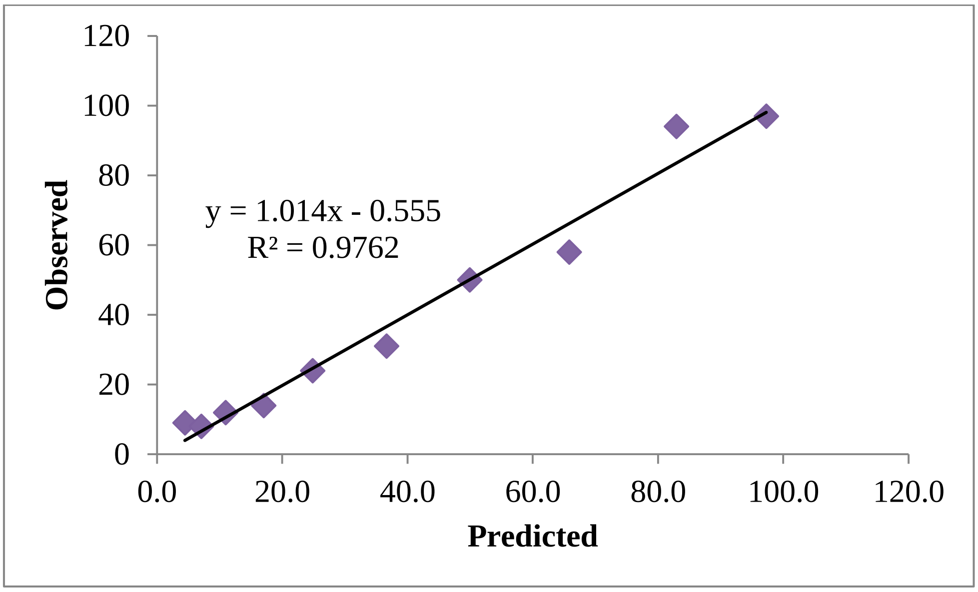

Figure 4.39: Predicted versus Observed Values by Rail Transit with Respect to Travel Cost Increment

Based on the results presented in Table 4.23, Figure 4.38 and Figure 4.39, it was discovered that there was a minor difference between the observed and predicted values for both modes of transport. The Chi-square value for the Hosmer-Lemeshow Test is 12.207 with significance levels of 0.142. This value is larger than 0.05, therefore indicating a good fit and support the model. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to travel cost increment, the model with all predictors as in Table 4.22 was statistically significant, $\chi 2$ (11, N = 234) = 371.014, $p < 0.05$, indicating that the model was able to distinguish between respondents who will be shifted and who will not be shifted to rail transit. The model as a whole explained between 23.2% (Cox & Snell R squared) and 33.4% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 89.7% of the private transport cases and 51.6% of the rail transit cases. In overall, the prediction was correctly classified 78.9% of cases, an improvement over the 71.7% in Block 0 (model without any of independent variables, IVs).

4.8.4.4 The Probability of Shifting with Respect to Travel Cost Increment

The mode share probabilities of rail transit mode with respect to travel cost increment is exhibited in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.40. The probability of shifting to rail transit is compared to private transport mode choice (reference category). Based on Table 4.22, the binary logit equation for shifting probability to rail transit mode with respect to travel cost increment is listed as below;

$$P = \frac{\text{EXP}(-2.295 - (0.352*\text{Gender}) + (0.354*\text{Access Mode}) + (0.085*\text{Age}) - (0.089*\text{Job}) + (0.018*\text{Income}) - (0.032*\text{License}) - (0.011*\text{Vehicle Availability}) - (0.137*\text{Education}) - (0.472*\text{Travel Purpose}) - (0.112*\text{Number of trip}) + (0.078*\text{Travel Cost Increment}))}{(1 + \text{EXP}(-2.295 - (0.352*\text{Gender}) + (0.354*\text{Access Mode}) + (0.085*\text{Age}) - (0.089*\text{Job}) + (0.018*\text{Income}) - (0.032*\text{License}) - (0.011*\text{Vehicle Availability}) - (0.137*\text{Education}) - (0.472*\text{Travel Purpose}) - (0.112*\text{Number of trip}) + (0.078*\text{Travel Cost Increment})))}$$

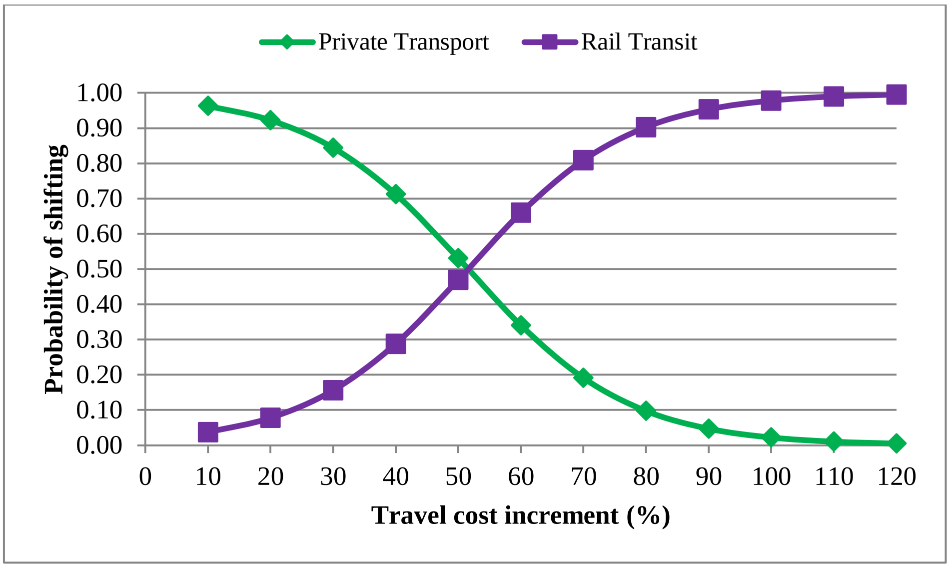

Figure 4.40: Probability of Shifting to Rail Transit With Respect To Travel Cost Increment

The percentage of private transport users shifting to rail transit increased from 4.0% until 100.0% with the increment of 10% until 120% from their current travel cost expenditure. At the same time, the probability of using private transport was decreased from 96.0% to 0.0% when their current travel cost expenditure was increased from 10% until 120%. A 50:50 split was attained when travel cost increment reached 52%. Based on their average current travel cost value, private transport users spent about RM15.40 (including the return journey) for their daily trip from home to final destination. By taking this value as baseline , the 100% shifting to rail transit would be achieved if their current travel cost increased to 130%, which was equal to RM33.90 (including the return journey). Although the average travel cost spent by private transport users was RM7.80 higher than rail transit users, the private transport users were consistently travel with their owns' vehicle. It showed a strong preference among private transport users to continue travel with their owns' vehicle despite of higher travel cost. It was proposed that higher travel cost can be determined as the trade-offs to comfortability, convenience and flexibility that travellers had when taking private transport as their daily mode. This is supported by the fact that about 86.8% of private transport users drive their car and only

13.2% of them used motorcycle in this study. As explained by Steg, (2003) and Dell'Olio et al., (2012), the private transport users preferred to use their owns' vehicle and hardly change their mode due to car attractiveness, to name a few; comfort, convenience, freedom, and flexible. Notably, the private transport users evaluated almost all car attractiveness positively although the car use was perceived to be expensive (Steg, 2003; Chuen et al., 2013; Van Acker et al., 2014). As explained by Dell'Olio et al., (2012), the LRT systems can be a popular alternative to buses because the system has its own installed track and would not be delayed by road congestion. Moreover, the LRT system would be more reliable than buses if the system operates at high frequencies with competitive fares. In addition, as discovered by Dell'Olio et al., (2012) and Knowles (1996), LRT is be used by an average of 6.5% more than bus. It was proposed that the finding on shifting probability with respect to travel cost increment can be proposed as an important indicator to transport planners and service operators in planning affordable rail fare, parking tariffs, introduce higher fuel taxes and congestion charge (Dell'Olio et al., 2012). At the same time improvement on rail-based transport services and related policies could be implemented in order to gain higher ridership, trust and loyalty from the users.

4.8.4.5 Scenario 3: Travel Time Increment

A summary of the estimations from the model with respect to travel time increment was tabulated in Table 4.24. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the travel time is about to increase and value 0 for those which will not shift to rail transit and travel consistently with private transport. The study found that out of the 11 predictor variables entered in the analysis, three predictor variables were found to be significant at least at the 0.05 level.

Table 4.24: Estimations from the Binary Mode Choice Model for Travel Time Scenario Increment

Variables	*Estimated Coefficient, B*	*S.E.*	*Wald*	*df*	*Sig.*	*Odds ratio*	*95% C.I.for EXP(B)*	
							Lower	**Upper**
Gender(1)	-0.230	0.165	1.936	1	0.164	0.795	0.575	1.099
Access Mode(1)	-0.335	0.210	2.558	1	0.110	0.715	0.474	1.078
Age	*0.189*	*0.065*	*8.595*	*1*	*0.003*	*1.209*	*1.065*	*1.372*
Job	0.042	0.080	0.282	1	0.595	1.043	0.892	1.220
Income	-0.089	0.078	1.284	1	0.257	0.915	0.785	1.067
License(1)	-0.326	0.260	1.566	1	0.211	0.722	0.433	1.203
Vehicle availability	*0.505*	*0.207*	*5.964*	*1*	*0.015*	*1.656*	*1.105*	*2.483*
Education	-0.008	0.120	0.004	1	0.949	0.992	0.785	1.254
Travel purpose(1)	-0.034	0.368	0.008	1	0.927	0.967	0.470	1.987
No. of trips per week	-0.020	0.084	0.058	1	0.809	0.980	0.832	1.154
Travel time increment	*0.070*	*0.006*	*116.079*	*1*	*0.000*	*1.072*	*1.059*	*1.086*
Constant	*-3.069*	*1.075*	*8.154*	*1*	*0.004*	*0.046*		
<u>*Summary of statistics*</u>								
(-2) log likelihood	*1052.384*							
Model chi-square	*151.069*							
Cox & Snell R^2	*0.121*							
Nagelkerke R^2	*0.189*							
Number of observations	*234*							

Note: (1) The reference category is private transport; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.24 was set to be used as reference. From table 4.24, the travel time coefficient, *B* was positive, which implied that the increased in travel time from home to final destination was likely to increase the probability of private transport users shifting to rail transit mode choice. For the age factor, elderly commuters were more likely to shift to rail transit mode than younger rail users if the travel time was about to increase. In this study, about 8.5% of the respondents aged 51 and above. The findings of the current study was consistent with Kamba et al. (2007) which found that elderly commuters were more likely to shift to bus and train compared to car with respect to travel time and travel cost increment. However, instead of travel cost, travel time and public transport fare either by rail or by bus, convenience and friendly facilities design should be taken into consideration in order to sufficiently cater public transportation services to all ages especially to elderly commuter (Gebeyehu & Takano, 2007). It was interesting to discover that as the number of vehicles increased, the private transport users were more likely to shift to rail transit with respect to travel time increment. However, in this study, only 11.1% of the private transport users have more than one vehicle for the journey. Therefore, more data on this characteristic could probably be collected in the future for more clarification.

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.25 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.41 and 4.42.

Table 4.25: Hosmer and Lemeshow's Test for Travel Time Decrement Scenario

		Rail transit		Private transport		
		Observed	Expected	Observed	Expected	Total
Step 1	1	107	111.085	10	5.915	117
	2	111	109.279	6	7.721	117
	3	104	107.449	13	9.551	117
	4	107	104.320	10	12.680	117
	5	106	100.542	11	16.458	117
	6	96	94.803	21	22.197	117
	7	85	88.171	32	28.829	117
	8	80	79.666	37	37.334	117
	9	69	70.645	48	46.355	117
	10	59	58.040	58	58.960	117
	Chi-square		df		Sig.	
	8.155		8		0.418	

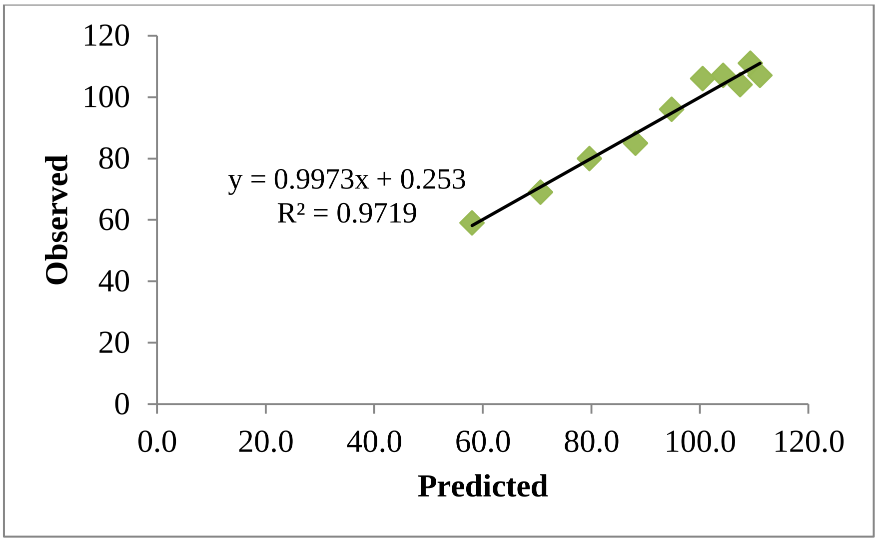

Figure 4.41: Predicted versus Observed Values by Private Transport with Respect to Travel Time Decrement

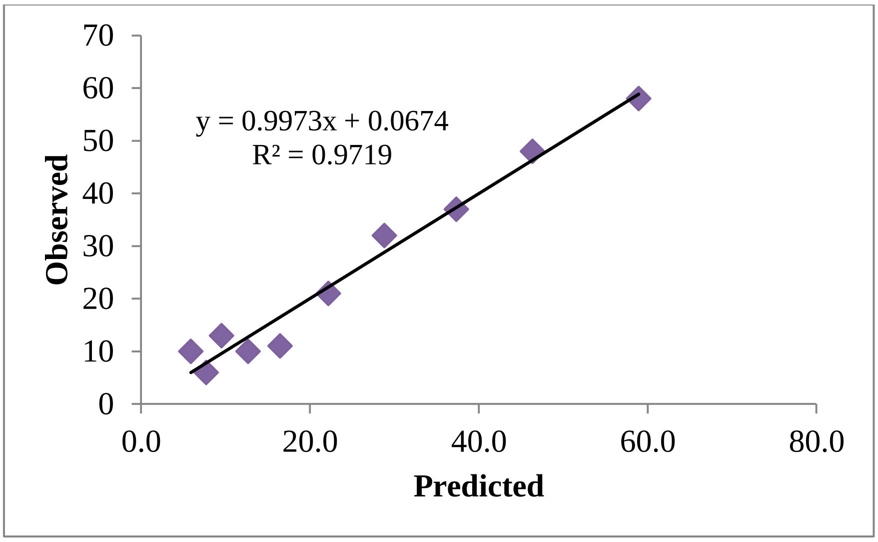

Figure 4.42: Predicted versus Observed Values by Rail Transit with Respect to Travel Time Decrement

The Chi-square value for the Hosmer-Lemeshow Test is 8.155 with significance levels of 0.418. This value is larger than 0.05, therefore indicating a good fit and support the model. In addition, the R-squared value in Figure 4.41 and 4.42 was closer to 1.0, which indicating the better fit of regression line. In another words, the closer the R-squared value to 1.0, the closer the line passes through all of the points. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected.

With respect to travel time increment, the model with all predictors was statistically significant, χ^2 (11, N = 234) = 151.069, $p < 0.05$, indicating that the model was able to distinguish between respondents who will be shifted and who will not be shifted to rail transit. The model as a whole explained between 12.1% (Cox & Snell R squared) and 18.9% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 12.6% of the rail transit cases and 97.6% of the private transport cases. In overall, the prediction was correctly classified 79.7% of cases, an improvement over 79.0% in Block 0 (model without any of independent variables).

4.8.4.6 The Probability of Shifting to Rail Transit With Respect To Travel Time Increment

The mode share probabilities of rail transit with respect to travel cost increment is exhibited in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.43. The probability of shifting to rail transit is compared to private transport mode choice (reference category). Based on Table 4.24, the binary logit equation for shifting probability to rail transit mode with respect to travel time increment is listed as below;

$$P = \frac{\text{EXP}(-3.069 - (0.230*\text{Gender}) - (0.335*\text{Access Mode}) + (0.189*\text{Age}) + (0.042*\text{Job}) - (0.089*\text{Income}) - (0.326*\text{License}) + (0.505*\text{Vehicle Availability}) - (0.008*\text{Education}) - (0.034*\text{Travel Purpose}) - (0.020*\text{Number of trip}) + (0.070*\text{Travel Time Increment}))}{(1 + \text{EXP}(-3.069 - (0.230*\text{Gender}) - (0.335*\text{Access Mode}) + (0.189*\text{Age}) + (0.042*\text{Job}) - (0.089*\text{Income}) - (0.326*\text{License}) + (0.505*\text{Vehicle Availability}) - (0.008*\text{Education}) - (0.034*\text{Travel Purpose}) - (0.020*\text{Number of trip}) + (0.070*\text{Travel Time Increment})))}$$

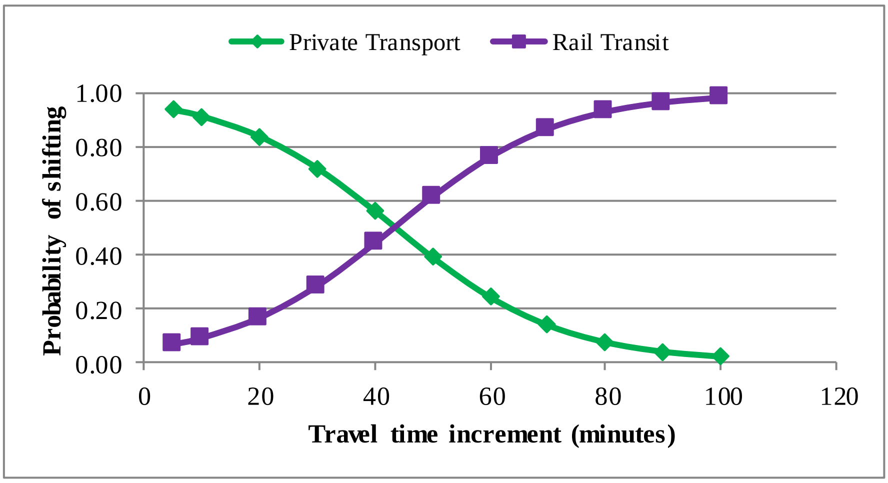

Figure 4.43: Probability of Shifting to Rail Transit With Respect To Travel Time Decrement

As depicted in Figure 4.43, it was discovered that the likelihood of shifting to rail transit was increased from 6.0% to 98.0% by 5 minutes to 100 minutes increment from their current travel time. At the same time, the probability of using private transport was decreased from 94.0% to 2.0% by 5 minutes to 60 minutes increment from their current travel time. Based on previous finding, the current average travel time by private transport was about 97 minutes (including the return trip) by taking various access modes. By taking this value as baseline, it can be proposed that the private transport users would completely shifted to rail transit mode if their current travel time was 197 minutes (97minutes + 100 minutes). A 50:50 split was attained at 44 minutes increment of current travel time. Therefore, based on current average travel time value, a 50:50 split would be at 141 minutes (97 + 44 minutes), which was more than 2 hours. In addition, about 42.3% of private transport users travelled above average current travel time and 29.1% of them took more than 2 hours (including the return trip) to reach their final destination. In other words, private transport users were struggling in terms of their daily travel time. The frequent car users were aware of the higher costs, which associated with the use of private transport as compared to public transport. However, their choice of using private transport was based on the reason that the journey by public transport would involve too many transfers and unreasonable travel time (Steg, 2003; Schwanen & Mokhtarian, 2005). The finding from this analysis would be beneficial to acquire some ideas on private transport users' views in voluntarily shifting to rail transit mode.

4.8.4.7 Scenario 4: Access Cost Decrement (Exclude Walking)

A summary of the estimations from the model with respect to access cost decrement was tabulated in Table 4.26. Similar to Scenario 1: Access Cost Increment, the private transport users who accessed rail station by walking were excluded in the analysis. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the travel cost is about to increase and value 0 for those which will not shift to rail transit and travel consistently with private transport. The study found that out of the 10 predictor variables entered in the analysis, only two predictor variables were found to be significant at least at the 0.05 level.

Table 4.26: Estimations from the Binary Mode Choice Model for Access Cost Decrement Scenario

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	-0.015	0.164	0.009	1	0.925	0.985	0.714	1.358
Age	-0.009	0.072	0.015	1	0.904	0.991	0.861	1.141
Job	0.014	0.082	0.028	1	0.867	1.014	0.864	1.190
Income	0.109	0.073	2.186	1	0.139	1.115	0.965	1.287
License(1)	-0.538	0.281	3.668	1	0.055	0.584	0.336	1.013

‘Table 4.26, continued’

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Vehicle availability	*0.452*	*0.218*	*4.308*	*1*	*0.038*	*1.571*	*1.025*	*2.406*
Education	0.177	0.124	2.039	1	0.153	1.193	0.936	1.520
Travel purpose(1)	-0.677	0.431	2.473	1	0.116	0.508	0.218	1.181
No. of trips per week	-0.125	0.089	1.961	1	0.161	0.883	0.742	1.051
Access cost decrement	0.067	0.005	154.249	1	0.000	1.069	1.058	1.080
Constant	-3.477	1.155	9.058	1	0.003	0.031		
<u>*Summary of statistics*</u> (-2) log likelihood Model chi-square Cox & Snell R^2 Nagelkerke R^2 Number of observations	 *1036.741* *234.518* *0.182* *0.274* *195*							

Note: (1) The reference category is rail transit; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. The positive sign of access cost indicated that the higher the access cost reduction from home to rail station, the more likely private transport users shift to rail transit mode. A significant access cost reduction will result in the reduction in parking tariff at station, taxi fare, bus fare and fuel price. Undeniably, access costs play a significant role in developing interest among frequent private transport to consider using rail transit more frequently and voluntarily. Private transport users who have more than one vehicle were more likely to shift to rail transit as access cost decreases. A possible explanation for this might be that the private transport users would use their vehicle as access mode to reach rail station rather than travel directly from home to their final destination if access cost is about to decrease. This is because about 67.5% of private transport users accessed rail station by using park and ride or drop-off facilities at the station if they travel with rail once in a while.

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.27 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.44 and 4.45. This test was recognized as the most reliable test of model fit in SPSS and was carried out in order to assess how well the model fitted the data and (Pallant, 2007).

Table 4.27: Hosmer and Lemeshow's Test for Increment of Access Cost Reduction Scenario

		Private transport		Rail transit		Total
		Observed	Expected	Observed	Expected	
Step 1	1	111	113.781	6	3.219	117
	2	113	111.280	4	5.720	117
	3	107	109.415	11	8.585	118
	4	106	103.974	10	12.026	116
	5	104	99.618	13	17.382	117
	6	91	92.975	26	24.025	117
	7	87	84.479	30	32.521	117
	8	75	74.135	42	42.865	117
	9	55	62.392	62	54.608	117
	10	48	44.952	69	72.048	117
	Chi-square		df		Sig.	
	8.138		8		0.420	

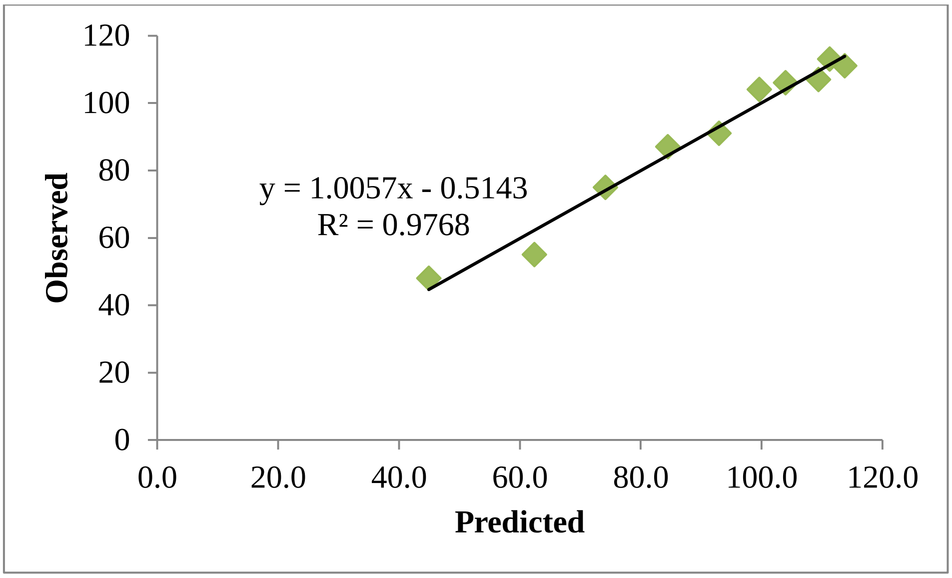

Figure 4.44: Predicted versus Observed Values by Private Transport with Respect to Increment of Access Cost Reduction

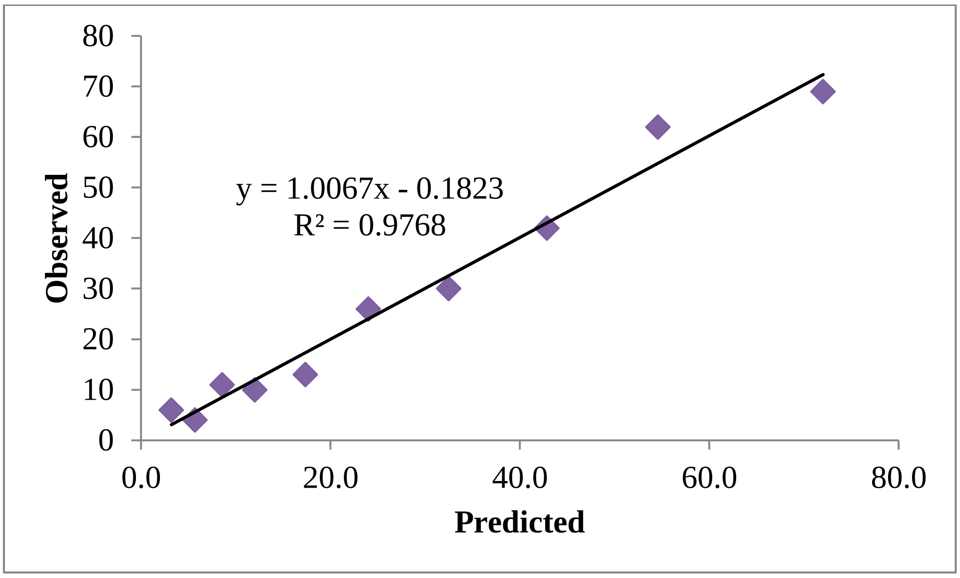

Figure 4.45: Predicted versus Observed Values by Rail Transit with Respect to Increment of Access Cost Reduction

Based on Table 4.27, Figure 4.44 and Figure 4.45, it was discovered that there was a minor difference between the observed and predicted values for both modes of transport as evidenced by the Chi-square value with a significance level of 0.420. This value is larger than 0.05, which indicated good fit and support the model. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to increment of access cost reduction, the model with all predictors in Table 4.26 containing all predictors was statistically significant, χ^2 (10, N =234) = 234.518, $p < 0.05$, indicating that the model was able to distinguish between respondents who will be shifted and who will not be shifted to rail transit. The model as a whole explained between 18.3% (Cox & Snell R squared) and 27.4% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 31.1% of the rail transit cases and 93.6% of the private transport cases. In overall, the prediction was correctly classified 79.1% of cases, an improvement over the 76.7% in Block 0 (model without any of independent variables).

4.8.4.8 The Probability of Shifting with Respect to Access Cost Decrement

The mode share probabilities was calculated by solving the binary logit equation for probability using a range of access cost decrement while keeping the other variables constant (according to the mean values). The probability of shifting to rail transit is compared to private transport mode (reference category). Based on Table 4.26, the binary logit equation for shifting probability to rail transit mode with respect to access cost decrement is listed as below;

$$P = \frac{\text{EXP}((-3.477 - (0.015*\text{Gender}) + (-0.009*\text{Age}) + (0.014*\text{Job}) + (0.109*\text{Income}) - (0.538*\text{License}) + (0.452*\text{Vehicle Availability}) + (0.177*\text{Education}) - (0.677*\text{Travel Purpose}) - (0.125*\text{Number of trip}) + (0.067*\text{Access Cost Decrement}))}{(1 + \text{EXP}((-3.477 - (0.015*\text{Gender}) + (-0.009*\text{Age}) + (0.014*\text{Job}) + (0.109*\text{Income}) - (0.538*\text{License}) + (0.452*\text{Vehicle Availability}) + (0.177*\text{Education}) - (0.677*\text{Travel Purpose}) - (0.125*\text{Number of trip}) + (0.067*\text{Access Cost Decrement})))}$$

The mode share probabilities of rail transit and private transport mode with respect to access cost decrement (exclude walking) is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.46 below.

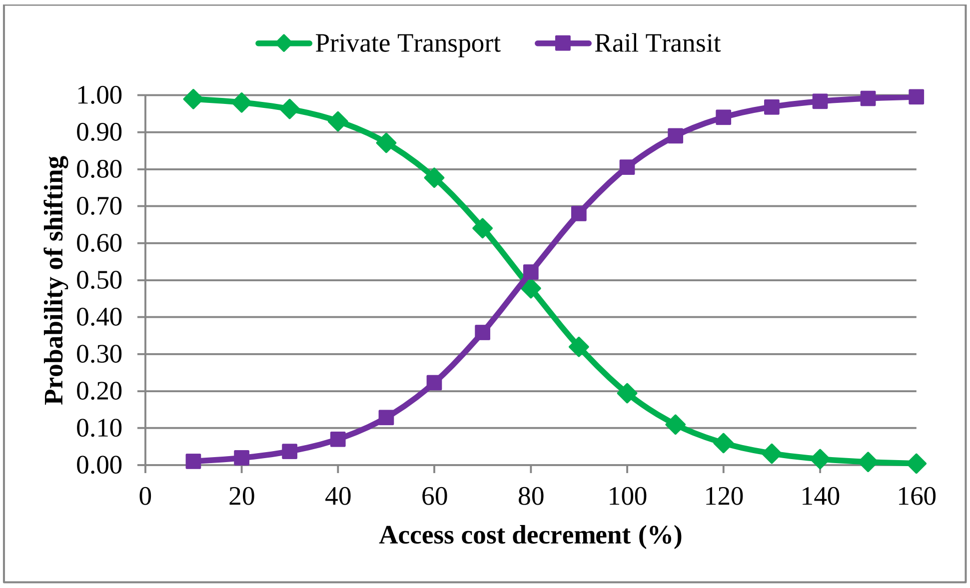

Figure 4.46: Probability of Shifting to Rail Transit Mode With Respect to Access Cost Reduction

The probability of shifting depicted stimulating tendency towards private transport mode by increment of current access cost from 10% to 160%. The probability of using rail transit increased from 1.0% likelihood to 100% when the access cost was decreased from 10% to 160% from their current access cost. Simultaneously, probability of using private transport decreased from 99.0% likelihood to 0.0% when the access cost was decreased from 10% to 160% from their current access cost. It was predicted that a 50:50 split may be achieved when the access cost decrement reach 80%. After 80%, of access cost decrement, the likelihood to choose rail transit was increased and the likelihood to travel by private transport was gradually decreased. Based on the current average access cost value of private transport users, the 80% reduction would be RM1.60. From another point of view, it was suggested that private transport users were hardly shifted to rail transit even though they have had experience travel by rail occasionally and were willing to trade-offs cost for comfort and reliable service quality. The past experience of private transport users when travelled by rail transit occasionally will either assist or not assist their travel mode choice decision. This situation is because of inertia effects, as discussed in previous section. This finding can be proposed as an important indicator to policy makers and transport planners to implement appropriate policies in controlling the use of private transport in the future and at the same time give meaningful input to the service operator to improve their service quality. The past findings showed that the commuters were more concerned on the public transport service and reliability rather than rail fare reduction (Kain & Liu, 1996; Hole, 2004; Miskeen et al., 2013).

4.8.4.9 Scenario 5: Access Time Decrement

A summary of the estimations from the model with respect to access time decrement was presented in Table 4.28. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the travel cost is about to increase and value 0 for those who will not shift to rail transit and travel consistently with private transport. The study found that out of the 11 predictor variables entered in the analysis, four predictor variables were found to be significant at least at the 0.05 level.

Table 4.28: Estimations from the Binary Mode Choice Model for Access Time Scenario Decrement

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	0.278	0.151	3.356	1	0.067	1.320	0.981	1.776
Access Mode(1)	-0.016	0.203	0.006	1	0.938	0.984	0.661	1.467
Age	0.088	0.061	2.074	1	0.150	1.092	0.969	1.231
Job	-0.037	0.073	0.252	1	0.616	0.964	0.835	1.113
Income	0.038	0.072	0.282	1	0.595	1.039	0.903	1.195
License(1)	*-0.495*	*0.245*	*4.064*	*1*	*0.044*	*0.610*	*0.377*	*0.986*
Vehicle availability	*0.487*	*0.200*	*5.938*	*1*	*0.015*	*1.628*	*1.100*	*2.409*
Education	0.064	0.111	0.333	1	0.564	1.066	0.857	1.326
Travel purpose(1)	*-0.685*	*0.349*	*3.859*	*1*	*0.049*	*0.504*	*0.254*	*0.998*
No. of trips per week	-0.063	0.078	0.647	1	0.421	0.939	0.806	1.094
Access time decrement	*0.095*	*0.006*	*237.652*	*1*	*0.000*	*1.100*	*1.086*	*1.113*
Constant	*-2.570*	*1.003*	*6.567*	*1*	*0.010*	*0.077*		
<u>*Summary of statistics*</u>								
(-2) log likelihood	*1196.667*							
Model chi-square	329.782							
Cox & Snell R^2	0.246							
Nagelkerke R^2	0.337							
Number of observations	234							

Note: (1) The reference category is private transport; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. The positive sign of access time indicated that the higher the access time reduction from home to rail station, the more likely private transport users shift to rail transit mode. Therefore, the null hypothesis that the coefficients (B) is equal to zero for these independent variables was rejected.

In addition, it was discovered that private transport users making other trip purposes rather than work trips were less likely to shift to rail transit by access time decrement. This is probably because private transport users who travelled for other purposes (education and personal), were not frequently travelled with their vehicle as compared to those who are working. In addition, they were not bounded to working hours and more flexible as compared to those who are using private transport for work. Therefore, the increment in access time reduction would not strongly affect their decision to shift to rail transit. It was also discovered that about 90.2% of the private transport users have driving license and were less likely to shift to rail transit despite of access time decrement. The private transport users with more than one vehicle were more likely to shift to rail transit with respect to increment of access time reduction. One of the issues, which will become a concern to private transport users when they travel by rail transit, was parking facilities at the station. This is because majority (67.5%) of private transport users utilized park and ride facilities when they travel by rail occasionally. Shifting likelihood to rail transit can be relate to parking facilities in the rail station and its surrounding area because users with work-related purposes have the longest parking duration, and travel during peak hours (Rodriguez & Targa, 2004; Simićević et al., 2012; Redman *et al*., 2013).

The Hosmer and Lemeshow’s Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.29 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.47 and 4.48.

Table 4.29: Hosmer and Lemeshow's Test for Access Time Decrement Scenario

		Private transport		Rail transit		Total
		Observed	Expected	Observed	Expected	
Step 1	1	108	109.888	10	8.112	118
	2	104	105.470	13	11.530	117
	3	100	101.890	17	15.110	117
	4	98	96.762	19	20.238	117
	5	90	87.247	27	29.753	117
	6	77	76.918	40	40.082	117
	7	67	62.356	50	54.644	117
	8	60	49.981	57	67.019	117
	9	25	35.911	92	81.089	117
	10	22	24.577	94	91.423	116
	Chi-square		df		Sig.	
	10.757		8		0.216	

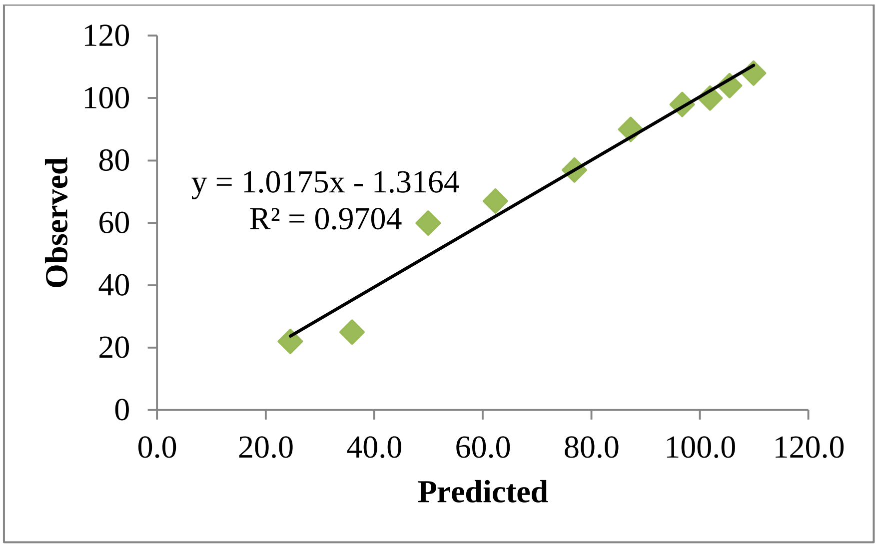

Figure 4.47: Predicted versus Observed Values by Private Transport with Respect to Access Time Decrement

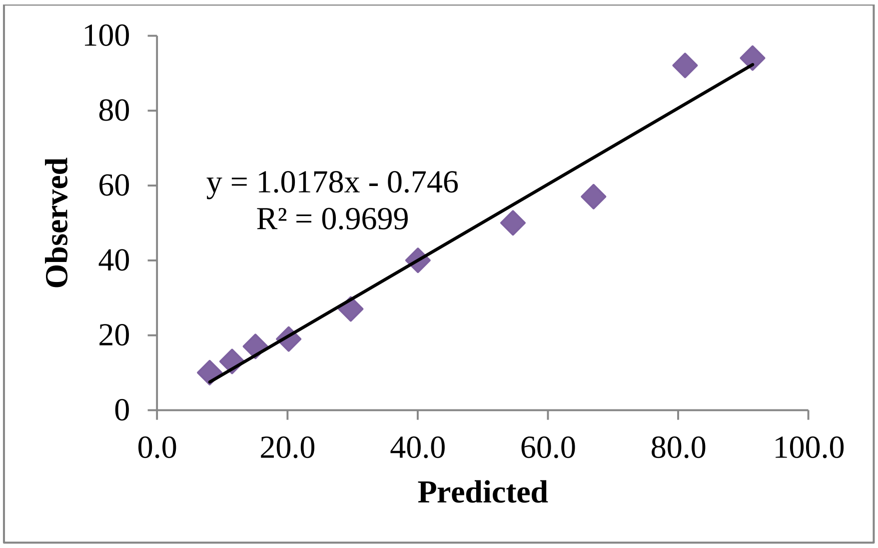

Figure 4.48: Predicted versus Observed Values by Rail Transit with Respect to Access Time Decrement

Based on the results as presented in Table 4.29, Figure 4.47 and Figure 4.48, it was discovered that there was a minor difference between the observed and predicted values for both modes of transport. The Chi-square value for the Hosmer-Lemeshow Test is 10.757 with significance level at 0.216. This value is larger than 0.05, which indicated good fit and support the model. The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to access time decrement, the model with all predictors as tabulated in Table 4.28 was statistically significant, χ^2 (11, N = 234) = 329.782, $p < 0.05$, indicating that the model was able to distinguish between respondents who will be shifted and who will not shifted to rail transit. The model as a whole explained between 24.6% (Cox & Snell R squared) and 33.7% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 58.7% of the rail transit cases and 84.0% of the private transport cases. In overall, the prediction was correctly classified 75.0% of cases, an improvement over the 64.2% in Block 0 (model without any of independent variables, IVs).

4.8.4.10 The Probability of Shifting with Respect to Access Time Decrement

The mode share probabilities of rail transit and private transport mode with respect to access time decrement is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.49. The probability of shifting to rail transit is compared to private mode (reference category). Based on Table 4.28, the binary logit equation for shifting probability to rail transit with respect to access time decrement scenario is listed as below;

$$P = \frac{\text{EXP}(-2.570 + (0.278*\text{Gender}) - (0.016*\text{Access Mode}) + (0.088*\text{Age}) - (0.037*\text{Job}) + (0.038*\text{Income}) - (0.495*\text{License}) + (0.487*\text{Vehicle Availability}) + (0.064*\text{Education}) - (0.685*\text{Travel Purpose}) - (0.063*\text{Number of trip}) + (0.095*\text{Access Time Decrement}))}{(1 + \text{EXP}(-2.570 + (0.278*\text{Gender}) - (0.016*\text{Access Mode}) + (0.088*\text{Age}) - (0.037*\text{Job}) + (0.038*\text{Income}) - (0.495*\text{License}) + (0.487*\text{Vehicle Availability}) + (0.064*\text{Education}) - (0.685*\text{Travel Purpose}) - (0.063*\text{Number of trip}) + (0.095*\text{Access Time Decrement})))}$$

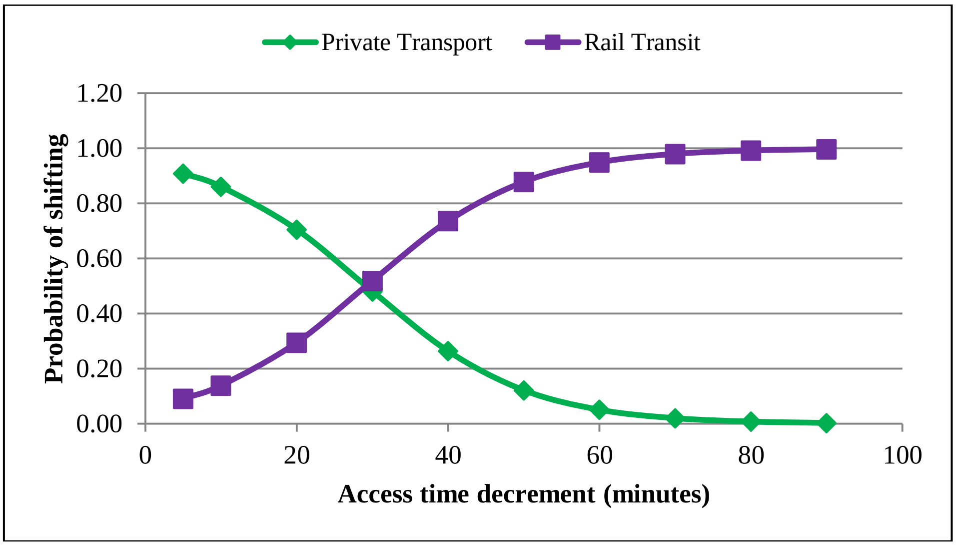

Figure 4.49: Probability of Shifting to Rail Transit Mode With Respect to Access Time Decrement

It is shown that the probability of shifting showed stimulating tendency to rail transit by increment of access time reduction. The shifting probability increased from 9.0% to 100% by decrement of 5 minutes to 90 minutes from their current access time. Interestingly, the private transport users would likely to shift to rail transit. Simultaneously, it was predicted that the probability of using private transport showed a reduction from 91.0% to 0.0% likelihood by decrement of 5 minutes to 90 minutes from their current access time. A 50:50 split was attained when access time decrement reached at 30 minutes. Based on current data, all private transport users travelled below 30 minutes from home to rail station when they travel by rail transit occasionally. it is interesting to observe that the shifting probability to rail transit reached 100% when access time decrement reach 90 minutes, which was nearly 1.5 hours. It is suggested that private transport users are vulnerable towards access time due to the relationship between access time and overall travel time. This is because any access time increment or decrement will affect the overall travel time (Rodriguez & Targa, 2004; Redman et al., 2013).In addition, the longer the travel time, the less accessible a person's experience is (Helling, 1998; Recker et al., 2001; Lau & Chiu, 2003; Redman et al., 2013). In addition, this finding showed significant influence of access time in private transport users' daily trip if they shift to rail transit in the future.

4.8.4.11 Scenario 6: Access Distance Decrement

A summary of the estimations from the model with respect to access distance increment was presented in Table 4.30. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the access distance is about to decrease and value 0 for those which will not shift to rail transit and travel consistently with private transport. The study found that out of the 11 predictor variables entered in the analysis, only two predictor variables were found to be significant at least at the 0.05 level.

Table 4.30: Estimations from the Binary Mode Choice Model for Access Distance Scenario Decrement

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	-0.021	0.149	0.020	1	0.887	0.979	0.731	1.311
Access Mode(1)	0.142	0.201	0.499	1	0.480	1.152	0.777	1.709
Age	0.108	0.060	3.214	1	0.073	1.114	0.990	1.253
Job	0.065	0.072	0.816	1	0.366	1.068	0.926	1.231
Income	0.006	0.071	0.006	1	0.936	1.006	0.876	1.155
License(1)	-0.531	0.242	4.836	1	0.028	0.588	0.366	0.944
Vehicle availability	0.323	0.198	2.664	1	0.103	1.381	0.937	2.034
Education	-0.019	0.109	0.031	1	0.859	0.981	0.792	1.215
Travel purpose(1)	0.092	0.340	0.073	1	0.787	1.096	0.563	2.136
No. of trips per week	-0.007	0.076	0.007	1	0.932	0.993	0.855	1.154
Access distance decrement	*0.005*	*0.000*	*266.635*	*1*	*0.000*	*1.005*	*1.004*	*1.006*
Constant	*-4.726*	*1.004*	*22.151*	*1*	*0.000*	*0.009*		
Summary of statistics								
(-2) log likelihood	1244.858							
Model chi-square	*431.140*							
Cox & Snell R^2	0.264							
Nagelkerke R^2	0.379							
Number of observations	234							

Note: (1) The reference category is private transport; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. The positive sign of access distance coefficient indicated that an increase in access distance decrement from home to rail station was likely to increase the probability of private transport users shifting to rail transit mode. About

90.2% of the private transport users had driving license and as the access distance reduction increased, the private transport users with license availability were less likely to shift to rail transit. As access distance decrement increased, the private transport users showed strong preference to consistently travel by their owns' vehicle. The decrement or increment of access distance was related to overall travel distance of private transport users. About 44.9% of the private transport users travelled more than 30km daily (including the return journey). Although, it was understood that the individuals who travelled more frequently by private transport will travel more in distance, it was discovered that the number of trips showed no significance difference on probability of shifting to rail transit by increment of access distance reduction. This finding is supported by Meloni et al., (2013), which highlighted that travel behaviours highly related to car usage are difficult to be shifted (inertia effect). In addition, individuals who travel more than 25k kilometres each year, are less likely to change their travel mode behaviour. This result appeared to suggest a general low preference among respondents to change travel mode, which is probably due to habits. Therefore, significance policies to promote voluntary behaviour change should be implemented through marketing campaign and delivering information about available alternatives (Cherchi & Manca, 2011; Meloni et al. 2013).

The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.31 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.50 and 4.51.

Table 4.31: Hosmer and Lemeshow's Test for Access Distance Decrement Scenario

		Private transport		Rail transit		Total
		Observed	Expected	Observed	Expected	
Step 1	1	133	137.361	7	2.639	140
	2	130	135.469	10	4.531	140
	3	128	132.126	12	7.874	140
	4	127	126.781	14	14.219	141
	5	125	117.784	15	22.216	140
	6	117	103.292	24	37.708	141
	7	102	86.097	38	53.903	140
	8	62	66.221	78	73.779	140
	9	47	55.501	93	84.499	140
	10	34	44.369	108	97.631	142
	Chi-square		df		Sig.	
	39.689		8		0.000	

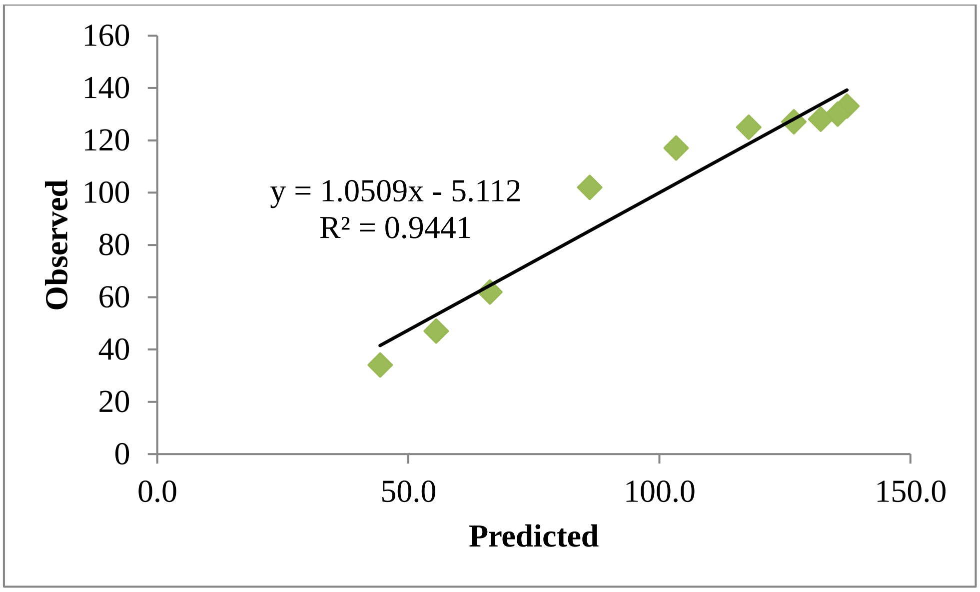

Figure 4.50: Predicted versus Observed Values by Private Transport with Respect to Access Distance Decrement

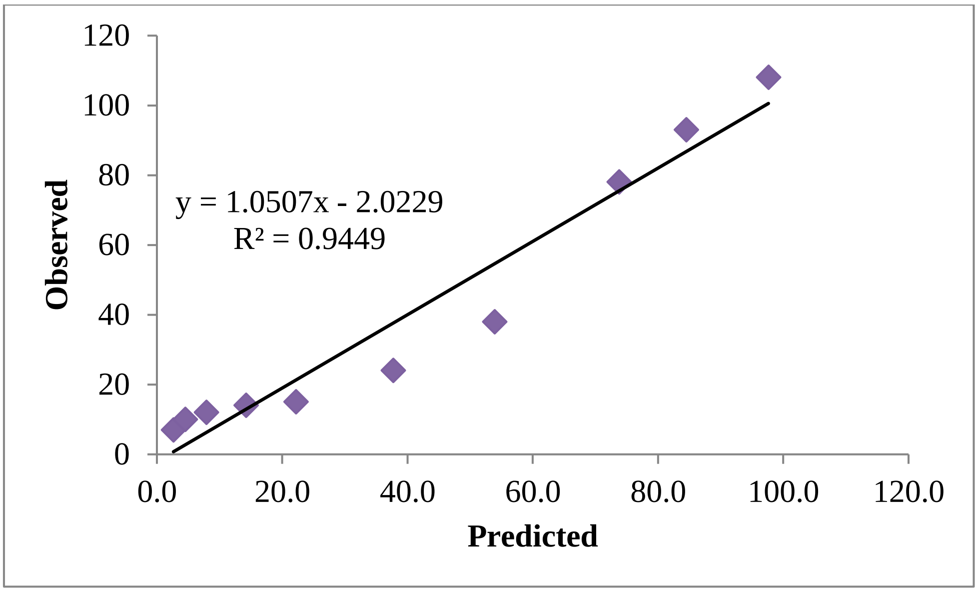

Figure 4.51: Predicted versus Observed Values by Rail Transit with Respect to Access Distance Decrement

Based on the results presented in Table 4.31, Figure 4.50 and Figure 4.51, it was discovered that there was a slight difference between the observed and predicted values for both modes of transport. The Chi-square value for the Hosmer-Lemeshow Test is 39.869 with significance level of less than 0.05, indicating a poor fit. However, a significant Hosmer-Lemeshow test does not necessarily mean that predictive models are not useful. The significant Hosmer-Lemeshow test statistic is due to large sample size (Marcin and Romano, 2007). However, the R-squared value in Figure 4.50 and 4.51 was closer to 1.0, which indicating the better fit of regression line. In another words, the closer R-squared value to 1.0, the closer the line passes through all of the points.

The log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to access distance decrement, the model with all predictors was statistically significant, χ^2 (11, N =234) = 431.140, $p < 0.05$, indicating that the model was able to distinguish between respondents (private transport users) who will be shifted and who will not be shifted to rail transit. The model as a whole explained between 26.4% (Cox & Snell R squared) and 37.9% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 66.2% of the rail transit cases and 87.3% of the private transport cases. In overall, the prediction was correctly classified 81.3% of cases, an improvement over the 71.6% in Block 0 (model without any of independent variables, IVs).

4.8.4.12 The Probability of Shifting with Respect to Access Distance Decrement

The mode share probabilities of rail transit and private transport mode with respect to access distance decrement is presented in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.52. The probability of shifting to rail transit is compared to private transport mode (reference category). Based on Table 4.30, the binary logit equation for shifting probability to rail transit mode with respect to access distance decrement is listed as below;

$$P = \frac{\text{EXP}\,(-4.726 - (0.021*\text{Gender}) + (0.142*\text{Access Mode}) + (0.108*\text{Age}) + (0.065*\text{Job}) + (0.006*\text{Income}) - (0.531*\text{License}) + (0.323*\text{Vehicle Availability}) - (0.019*\text{Education}) + (0.092*\text{Travel Purpose}) - (0.007*\text{Number of trip}) + (0.005*\text{Access Distance Increment}))}{(1 + \text{EXP}\,(-4.726 - (0.021*\text{Gender}) + (0.142*\text{Access Mode}) + (0.108*\text{Age}) + (0.065*\text{Job}) + (0.006*\text{Income}) - (0.531*\text{License}) + (0.323*\text{Vehicle Availability}) - (0.019*\text{Education}) + (0.092*\text{Travel Purpose}) - (0.007*\text{Number of trip}) + (0.005*\text{Access Distance Increment})))}$$

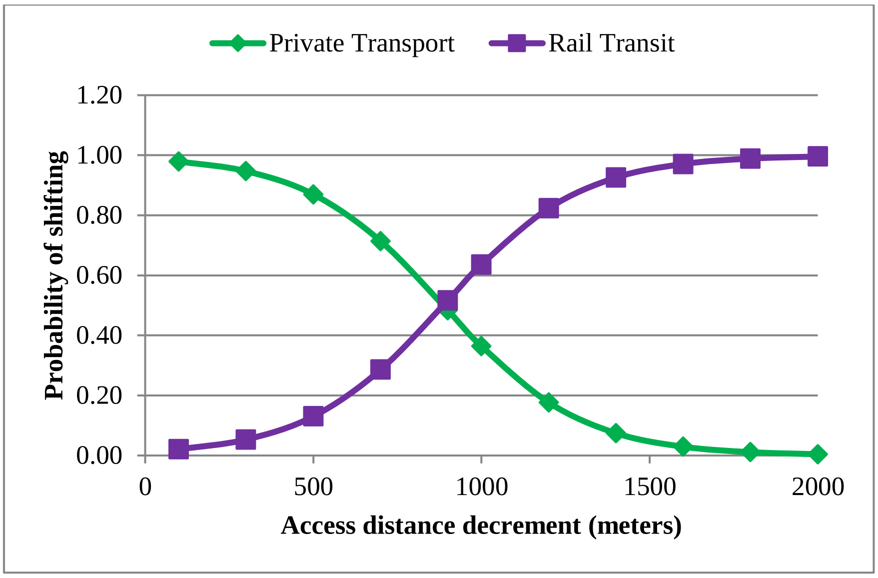

Figure 4.52: Probability of Shifting to Rail Transit Mode With Respect to Access Distance Decrement

The percentage of private transport users shifting to rail transit increased from 2.0% to 100.0% with the increment of 100m to 2000m reduction from their current access distance. At the same time, the probability of using private transport was decreased from 98.0% to 0.0% with the increment of 100m to 2000m reduction from their current access distance. A 50:50 split was attained when access distance decrement reached 900m. Therefore, decrement of access distance until 900 m will strongly incline the shifting probability towards rail transit mode because private transport users considered the access distance decrement is in the range of acceptable access distance. Therefore, it was suggested that any access distance decrement will strongly affect the decision of private transport users whether they will consistently travel with private transport or shift to rail transit. Through cross-tabulation between access modes and access trip length, walking to rail station was identified as the main access mode for short access distance, in the range of 0-500m, which was 16.7%. As expected, private transport users (41.0%) utilized the park and ride facilities for access distance of more than 1000m. Although private transport users travelled with rail occasionally, it was discovered that they will hypothetically shifted to rail transit (100%) if their current access distance were decreased about 2000m. In addition, it was predicted that private transport users will fully utilized the park and ride facilities in the station if they shift to rail in the future, which would benefit commuters with vehicle availability. Thus, by implementing appropriate facilities in relation to improvement of access mode distance e.g. by providing better service of bus and taxi, and by providing safe and more parking area, it could provide opportunities to private transport users to consider shifting to rail transit voluntarily at least once a week. In addition, the trip makers viewed the rail commuter system and its park-and-ride facilities as the better alternative form of transportation than using private vehicles to travel from suburbs to the city centre (Hamid et al., 2007;Hamid et al., 2011). The relevant suggested policies would lead to less congestion on the streets in the city centre because of the presence of fewer vehicles. In the long term, it is believed to be able to improve the modal split that favours more of the public transport as the ideal form of sustainable transport system towards reducing urban congestion.

4.8.4.13 Scenario 7: Rail Frequency Increment

The private transport users' likelihood to shift to rail transit under hypothetically sequence increment of rail frequency scenarios was discussed. A summary of the estimations from the model with respect to rail frequency increment was tabulated in Table 4.32. The dependent variable, travel mode choice, took the form of a dummy with value 1 denoting the private transport users who will shift to rail transit if the access distance is about to decrease and value 0 for those who will not shift to rail transit and travel consistently with private transport. The study found that out of the 11 predictor variables entered in the analysis, three predictor variables were found to be significant at least at the 0.05 level.

Table 4.32: Estimations from the Binary Mode Choice Model for Rail Frequency Increment Scenario

Variables	***Estimated Coefficient, B***	***S.E.***	***Wald***	***df***	***Sig.***	***Odds ratio***	***95% C.I.for EXP(B)***	
							Lower	**Upper**
Gender(1)	-0.257	0.159	2.611	1	0.106	0.774	0.567	1.056
Access Mode(1)	0.362	0.215	2.816	1	0.093	1.436	0.941	2.190
Age	-0.047	0.064	0.539	1	0.463	0.954	0.841	1.082
Job	-0.124	0.076	2.672	1	0.102	0.883	0.761	1.025
Income	-0.056	0.075	0.561	1	0.454	0.946	0.817	1.095
License(1)	-0.670	0.247	7.341	1	0.007	0.512	0.315	0.831
Vehicle availability	-0.054	0.218	0.062	1	0.803	0.947	0.617	1.453
Education	0.054	0.115	0.224	1	0.636	1.056	0.843	1.322
Travel purpose(1)	-0.769	0.365	4.434	1	0.035	0.464	0.227	0.948
No. of trips per week	0.020	0.081	0.063	1	0.802	1.021	0.870	1.197
Rail frequency increment	0.858	0.062	190.379	1	0.000	2.359	2.088	2.664
Constant	-6.215	1.129	30.298	1	0.000	0.002		
<u>*Summary of statistics*</u>								
(-2) log likelihood	*1112.685*							
Model chi-square	*275.581*							
Cox & Snell R^2	*0.210*							
Nagelkerke R^2	*0.302*							
Number of observations	*234*							

Note: (1) The reference category is private transport; (2) Variables in italic indicates significant values at or above the 95 percent

The categorical predictors were exhibited with number one in bracket, (1). Therefore, for categorical predictors, the first group which was coded as 0 as depicted in Table 4.6 was set to be used as reference. In this study, the rail frequency was hypothetically assumed as six times per hour. The hypothetical stated preference scenario design for rail frequency was designed by increasing the assumed current frequency (6 times per hours), from 7 times to 13 times per hour. In other words, the waiting time for each rail was in every 8.6 minutes to 5.0 minutes. The positive sign of rail frequency coefficient indicated that an increase in rail frequency from home to rail station was likely to increase the probability of private transport users shifting to rail transit mode. As expected, the private transport users were more likely to shift to rail transit mode by rail frequency increment. It was found that private transport users, which have driving license, were less likely to shift to rail transit than private transport users without driving license by rail frequency increment. It was also discovered that the private transport users who travel daily for other purposes were less likely to shift to rail transit as compared to those who travel daily for work. The Hosmer and Lemeshow's Goodness-of-Fit Test statistic and a Chi-square test between the observed and expected frequencies was presented in Table 4.33 below. The predicted (expected) versus observed values for each travel mode were plotted in Figure 4.53 and 4.54.

Table 4.33: Hosmer and Lemeshow's Test for Rail Frequency Increment Scenario

		Private transport		Rail transit		
		Observed	Expected	Observed	Expected	Total
Step 1	1	112	112.600	5	4.400	117
	2	105	110.256	12	6.744	117
	3	107	106.390	10	10.610	117
	4	100	102.077	17	14.923	117
	5	102	94.752	15	22.248	117
	6	86	87.049	31	29.951	117
	7	85	75.378	32	41.622	117
	8	63	64.678	54	52.322	117
	9	52	50.887	65	66.113	117
	10	30	37.932	87	79.068	117
	Chi-square		df		Sig.	
	13.816		8		0.087	

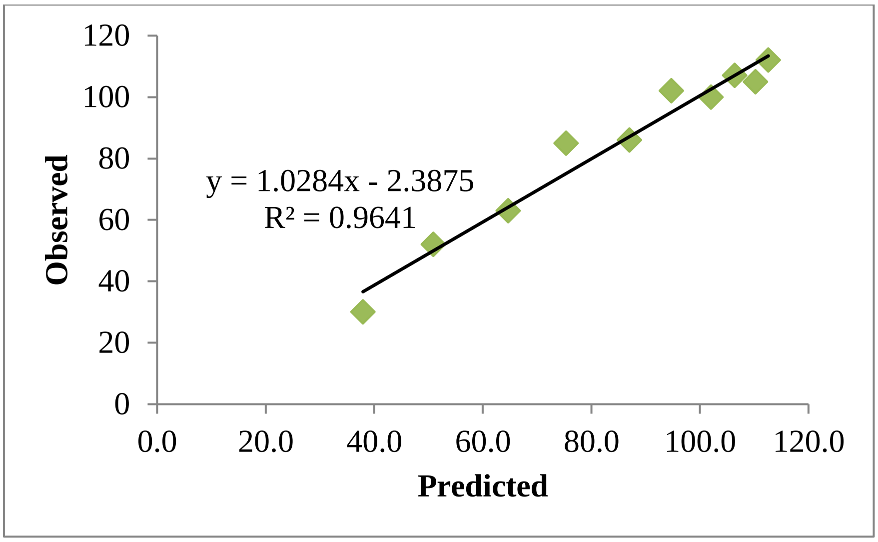

Figure 4.53: Predicted versus Observed Values by Private Transport with Respect to Rail Frequency Increment

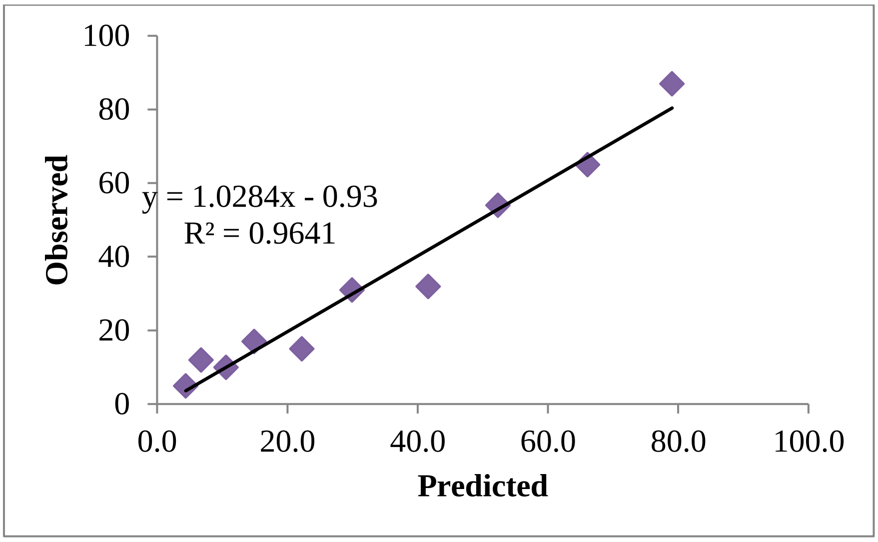

Figure 4.54: Predicted versus Observed Values by Rail Transit with Respect to Rail Frequency Increment

Based on Figure 4.53 and 4.54, there was a slight difference between the observed and predicted values for both modes of transport. The Chi-square value was 13.816 with a significance level of 0.087. This value is larger than 0.05, therefore indicating support for the model. In addition, the log-likelihood change test indicated that all the models are significant at 0% level and null hypothesis is rejected. With respect to rail frequency increment, the model with all predictors was statistically significant, χ^2 (11, N = 234) = 1112.685, $p < 0.05$. This indicated that the model was able to distinguish between private transport users who will be shifted and who will not be shifted to rail transit. The model as a whole explained between 21.0% (Cox & Snell R squared) and 30.2% (Nagelkerke R squared) of the variance in shifting probability, and correctly classified 46.6% of the rail transit cases and 89.7% of the private transport cases. In overall, the prediction was correctly classified 77.6% of cases, an improvement over the 72.0% in Block 0 (model without any of independent variables).

4.8.4.14 The Probability of Shifting with Respect to Rail Frequency Increment

The mode share probability of rail transit mode with respect to rail frequency increment is exhibited in a sigmoidal or S-shaped logistic regression graph as shown in Figure 4.55. The probability of shifting to rail transit is compared to private transport mode choice (reference category). Based on Table 4.32, the binary logit equation for shifting probability to rail transit mode with respect to rail frequency increment is listed as below;

$$P = \frac{\text{EXP}(-6.215 - (0.257*\text{Gender}) + (0.362*\text{Access Mode}) + (0.047*\text{Age}) - (0.124*\text{Job}) - (0.056*\text{Income}) - (0.670*\text{License}) - (0.054*\text{Vehicle Availability}) + (0.054*\text{Education}) - (0.769*\text{Travel Purpose}) + (0.020*\text{Number of trip}) + (0.858*\text{Rail Frequency Increment}))}{(1 + \text{EXP}(-6.215 - (0.257*\text{Gender}) + (0.362*\text{Access Mode}) + (0.047*\text{Age}) - (0.124*\text{Job}) - (0.056*\text{Income}) - (0.670*\text{License}) - (0.054*\text{Vehicle Availability}) + (0.054*\text{Education}) - (0.769*\text{Travel Purpose}) + (0.020*\text{Number of trip}) + (0.858*\text{Rail Frequency Increment})))}$$

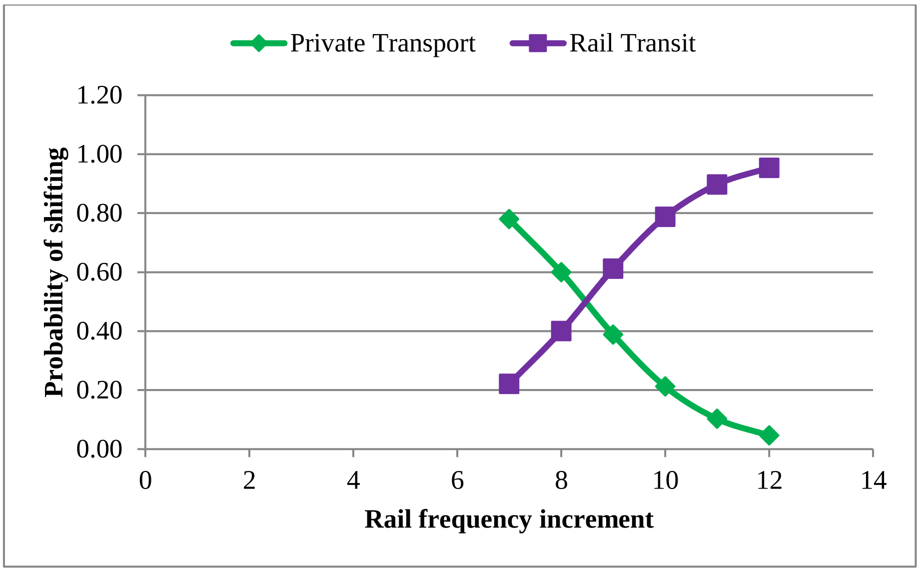

Figure 4.55: Probability of Shifting to Rail Transit With Respect To Rail Frequency Decrement

It was previously mentioned that the current rail frequency was assumed as 6 times per hour (10 minutes interval for each rail transit arrival). In the analysis, the assumed rail frequency was increased from 7 times to 12 times per hour. It was discovered that the likelihood of shifting to rail transit was increased from 22.0% to 95.0% when the rail frequency was increased from 7 times to 12 times per hour. Simultaneously, the probability of using private transport showed a reduction from 78.0% to 5.0% by rail frequency increment. Based on the current condition in Klang Valley (KV), the rail transit frequencies in Klang Valley were varied due to route coverage area and rail system capabilities. The highest rail headway was recorded at 3 minutes per hour (about 20 times per hour) during peak period. This service was provided by Light Rail Transit (LRT) system of Kelana Jaya Line. The lowest rail headway was recorded at 15 minutes per hour (about 4 times per hour) during peak period. This service was provided by KTM Komuter system of Rawang-Seremban Line and Port Klang-Batu Caves Line. According to Commision, (2013) report, it was highlighted that current rail travellers are dissatisfied with KTM Komuter services and it was identified that 12 out of 50 KTM Komuter rail stations are operated with low riderships, which were less than 250 passengers per day. It was identified that the inaccessibility from surrounding areas as well as the low frequency and slow journey times on KTM Komuter were the factors which contributed to this issue (Pemandu, 2010; Land Public Transport Commission, 2013). In addition, the inclination towards rail transit mode arised continuosly after current assumed rail frequency was increased from 8 times per hours onwards. Based on the finding, it is important to realize on how influential of rail regularity to private transport users in order to encourage them to start using rail transit voluntarily and more frequently.

4.9 Importance-Performance Analysis (IPA) on Accessibility to Rail Transit System

This section focuses on the service quality of access modes that frequent rail users utilized to reach rail transit station in Klang Valley, Malaysia based on their perception. According to Transportation Research Board (TRB) (2003), service quality is the overall measured or perceived performance of transport system service from the passenger's point of view. However, the clarification of quality transport system varies with respect to different level of society development, different socio-demographic and economic categories of population as well as the transport system itself (Grujicic et al., 2014). The aim of Importance-Performance Analysis (IPA) is to find ways to improve the quality of accessibility to rail transit system from frequent rail users point of view. In order to improve current accessibility to rail transit station, service providers and responsible authorities should therefore prioritize quality attributes that have higher importance levels and lower satisfaction levels. The current practices of IPA are applied in determining service quality of products or services in various field and areas. It is used to identify the parameters or attributes of products or services that are the priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance (Eskildsen and Kristensen, 2006; Wu and Shieh, 2009; Wei et al., 2011; Grujicic et al., 2014).

From Zhao et al. (2002) study, accessibility was identified as one of the factors that affecting public transport usage. In relation to this study, the service quality performance of accessibility to rail transit station were investigated. As mentioned previously in methodology, the IPA with confidence interval was applied in order to make IPA method more effective. This IPA method with integrated confidence intervals was introduced by Wu and Shieh (2009). In this method, any item or parameters, which are located in two-dimensional matrix of the coordinate system, are considered. In addition, IPA method with confidence intervals will enable the decision maker to identify the strength and weaknesses based upon the sample size used (Grujicic et al., 2014).

In this study, list of 37 accessibility service quality elements based on several literatures were investigated (Wibowo, 2010; Grujicic et al, 2014). The accessibility service quality elements were divided into five parts. These five parts were designed based on access modes type that frequent rail users took from home to reach rail station. In other words, the respondents have to answer the questions which are related to their access mode in the survey. The first part is for walking mode with 11 accessibility service quality elements. The second part is for taxi mode with 8 accessibility service quality elements. The third part is for bus mode with 8 accessibility service quality elements. The fourth part is for park and ride mode with 6 accessibility service quality elements. Lastly, the fifth part is for drop-off mode with 5 accessibility service quality elements.

One of the important elements, which were not highlighted or less focused in past studies, was accessibility for people with disability (Das et al., 2013; Grujicic et al., 2014). In this study, the satisfaction and importance level of accessibility for people with disability was included in each access mode section. Throughout this study, the frequent rail users provided an assessment on satisfaction and importance level for all 37 accessibility service quality elements. The satisfaction and importance level was graded using Likert scale, from 1 = *not at all satisfied/not at all important*, 2 = *slightly satisfied/slightly important*, 3 = *moderately satisfied/moderately import*ance, 4 = *very satisfied/very importance* and 5 = *extremely satisfied/extremely important*.

About 335 valid questionnaires were collected for analysis. The sample size for each access mode is different. There were 112 (33.4%) respondents that walked, 45 (13.4%) respondents used taxi, and 54 (16.1%) respondents used bus to reach rail station. In addition, there were 66 (19.7%) respondents used park and ride facilities and about 17.3% (58 respondents) use drop-off facilities at the rail station. The descriptive statistics of socio-demographic and socio-economic analysis for each access mode is tabulated in Table 4.34 below.

Table 4.34: Distribution of Descriptive Statistics Analysis for Each Access Mode

Type of access mode	Variables	Proportion (%)
Walking (112 respondents, 33.4%)	**Gender** Male Female	 42.9 57.1
	Ethnicity Malay Chinese Indian Others	 62.5 17.0 8.9 11.6
	Nationality Malaysian Non-Malaysian	 90.2 9.8

'Table 4.34, continued'

Type of access mode	Variables	Proportion (%)
	Age	
	18-24	37.5
	24-30	39.3
	31-40	12.5
	41-50	3.6
	51-60	5.4
	> 60	1.8
	Marital status	
	Single	71.4
	Married, no kids	8.0
	Married, have kids	18.8
	Others	1.8
	Job status	
	Pensioner/Housewives/Part-time job	3.6
	Student	26.8
	Blue collar jobs	9.8
	White collar jobs	25.0
	Self-employed/Businessman	1.8
	Management & Executive	7.1
	Professional	25.9
	Monthly income	
	Less or equal to RM1000	33.0
	RM1001 - RM2000	23.2
	RM2001 - RM3000	17.9
	RM3001 - RM4000	15.2
	RM4001 - RM5000	3.6
	More or equal to RM5001	7.1
	Licensed driver	
	Yes	70.5
	No	29.5
	Vehicle ownership	
	No vehicle available	34.8
	Vehicle available	65.2
	Availability of vehicle (per household)	
	1	80.4
	2	19.6
	Highest education	
	Primary/Secondary School	28.6
	Pre-University/Diploma	23.2
	Degree	40.2
	Postgraduate (Master/PhD)	8.0
	Travel purpose	
	Workplace/office	68.8
	Other (Education/Recreation/Personal)	31.2
	Number of trips per week	
	8-9 times	17.9
	10-11times	77.7
	>12 times	4.4

‘Table 4.34, continued’

Type of access mode	Variables	Proportion (%)
Taxi (45 respondents, 13.4%)	**Gender**	
	Male	31.1
	Female	68.9
	Ethnicity	
	Malay	48.9
	Chinese	33.3
	Indian	8.9
	Others	8.9
	Nationality	
	Malaysian	86.7
	Non-Malaysian	13.3
	Age	
	18-24	48.9
	24-30	11.1
	31-40	26.7
	41-50	8.9
	51-60	4.4
	> 60	0.0
	Marital status	
	Single	60.0
	Married, no kids	8.9
	Married, have kids	28.9
	Others	2.2
	Job status	
	Pensioner/Housewives/Part-time job	6.7
	Student	33.3
	Blue collar jobs	11.1
	White collar jobs	24.4
	Self-employed/Businessman	0.0
	Management & Executive	20.0
	Professional	4.4
	Monthly income	
	Less or equal to RM1000	28.9
	RM1001 - RM2000	35.6
	RM2001 - RM3000	17.8
	RM3001 - RM4000	8.9
	RM4001 - RM5000	0.0
	More or equal to RM5001	8.9
	Licensed driver	
	Yes	73.3
	No	26.7
	Vehicle ownership	
	No vehicle available	44.4
	Vehicle available	55.6

‘Table 4.34, continued’

Type of access mode	Variables	Proportion (%)
	Availability of vehicle (per household)	
	1	71.1
	2	26.7
	3	2.2
	Highest education	
	Primary/Secondary School	31.1
	Pre-University/Diploma	31.1
	Degree	33.3
	Postgraduate (Master/PhD)	4.4
	Travel purpose	
	Workplace/office	60.0
	Other (Education/Recreation/Personal)	40.0
	Number of trips per week	
	8-9 times	28.9
	10-11	51.1
	>12 times	20.0
Bus (54 respondents, 16.1%)	**Gender**	
	Male	54.7
	Female	45.3
	Ethnicity	
	Malay	50.0
	Chinese	27.8
	Indian	11.1
	Others	11.1
	Nationality	
	Malaysian	88.9
	Non-Malaysian	11.1
	Age	
	18-24	51.9
	24-30	22.2
	31-40	14.8
	41-50	7.4
	51-60	1.9
	> 60	1.9
	Marital status	
	Single	83.3
	Married, no kids	3.7
	Married, have kids	13.0
	Others	0.0
	Job status	
	Pensioner/Housewives/Part-time job	9.3
	Student	7.0
	Blue collar jobs	18.5
	White collar jobs	20.4
	Self-employed/Businessman	0.0
	Management & Executive	9.3
	Professional	5.6

‘Table 4.34, continued’

Type of access mode	Variables	Proportion (%)
	Monthly income	
	Less or equal to RM1000	46.3
	RM1001 - RM2000	22.2
	RM2001 - RM3000	16.7
	RM3001 - RM4000	7.4
	RM4001 - RM5000	1.9
	More or equal to RM5001	5.6
	Licensed driver	
	Yes	63.0
	No	37.0
	Vehicle ownership	
	No vehicle available	64.8
	Vehicle available	35.2
	Availability of vehicle (per household)	
	1	90.7
	2	9.3
	Highest education	
	Primary/Secondary School	35.2
	Pre-University/Diploma	27.8
	Degree	35.2
	Postgraduate (Master/PhD)	1.9
	Travel purpose	
	Workplace/office	59.3
	Other (Education/Recreation/Personal)	40.7
	Number of trips per week	
	8-9 times	27.8
	10-11times	61.1
	>12 times	11.1
Park and Ride (66 respondents, 19.7%)	**Gender**	
	Male	66.7
	Female	33.3
	Ethnicity	
	Malay	66.7
	Chinese	21.2
	Indian	9.1
	Others	3.0
	Nationality	
	Malaysian	98.5
	Non-Malaysian	1.5
	Age	
	18-24	27.3
	24-30	31.8
	31-40	25.8
	41-50	6.1
	51-60	7.6
	> 60	1.5

‘Table 4.34, continued’

Type of access mode	Variables	Proportion (%)
	Marital status	
	Single	57.6
	Married, no kids	10.6
	Married, have kids	28.8
	Others	3.0
	Job status	
	Pensioner/Housewives/Part-time job	1.5
	Student	27.3
	Blue collar jobs	10.6
	White collar jobs	7.6
	Self-employed/Businessman	6.1
	Management & Executive	9.1
	Professional	37.9
	Monthly income	
	Less or equal to RM1000	24.2
	RM1001 - RM2000	4.5
	RM2001 - RM3000	21.2
	RM3001 - RM4000	15.2
	RM4001 - RM5000	7.6
	More or equal to RM5001	27.3
	Licensed driver	
	Yes	100.0
	No	0.0
	Vehicle ownership	
	No vehicle available	0.0
	Vehicle available	100.0
	Availability of vehicle (per household)	
	1	69.7
	2	28.8
	3	1.5
	Highest education	
	Primary/Secondary School	3.0
	Pre-University/Diploma	15.2
	Degree	60.6
	Postgraduate (Master/PhD)	21.2
	Travel purpose	
	Workplace/office	59.1
	Other (Education/Recreation/Personal)	40.9
	Number of trips per week	
	8-9 times	43.9
	10-11times	51.5
	>12 times	4.5
Drop-off (58 respondents, 17.3%)	**Gender**	
	Male	44.8
	Female	55.2

‘Table 4.34, continued’

Type of access mode	Variables	Proportion (%)
	Ethnicity	
	Malay	51.7
	Chinese	27.6
	Indian	20.7
	Others	0.0
	Nationality	
	Malaysian	100.0
	Non-Malaysian	0.0
	Age	
	18-24	44.8
	24-30	27.6
	31-40	10.3
	41-50	13.8
	51-60	3.4
	> 60	0.0
	Marital status	
	Single	63.8
	Married, no kids	6.9
	Married, have kids	24.1
	Others	5.2
	Job status	
	Pensioner/Housewives/Part-time job	8.6
	Student	34.5
	Blue collar jobs	13.8
	White collar jobs	19.0
	Self-employed/Businessman	3.4
	Management & Executive	6.9
	Professional	13.8
	Monthly income	
	Less or equal to RM1000	37.9
	RM1001 - RM2000	27.6
	RM2001 - RM3000	19.0
	RM3001 - RM4000	10.3
	RM4001 - RM5000	0.0
	More or equal to RM5001	5.2
	Licensed driver	
	Yes	70.7
	No	29.3
	Vehicle ownership	
	No vehicle available	41.4
	Vehicle available	58.6
	Availability of vehicle (per household)	
	1	82.8
	2	17.2

Table 4.34, continued'

Type of access mode	Variables	Proportion (%)
	Highest education	
	Primary/Secondary School	25.9
	Pre-University/Diploma	36.2
	Degree	29.3
	Postgraduate (Master/PhD)	8.6
	Travel purpose	
	Workplace/office	55.2
	Other (Education/Recreation/Personal)	44.8
	Number of trips per week	
	8-9 times	32.8
	10-11times	62.1
	>12 times	5.2

From Table 4.34, it was discovered that the percentage of female users are higher than male users for walking, taxi and drop-off mode. As expected, the percentage of male users are higher than female users for bus and park and ride mode. Despite of different access modes that frequent rail users took to reach rail station, it was found that majority of them is Malay. This finding was parallel to the overall distribution of descriptive statistics for frequent rail users. Malaysian was found to be the majority of all the access modes used to reach rail station. This is due to lower samples size from Non-Malaysian respondents. As for age categories, majority of the younger rail users, aged between 18 to 30 years old (76.4%) preferred to walk to reach rail station as compared to other age categories. In addition, majority of the younger rail users, age between 18-24 years old (50.9%) preferred to use bus as their access mode to reach rail station. For park and ride mode, the percentage of rail users scattered quite evenly between aged 18 to 40 years old. From the data, it was apparent that single frequent rail transit users (71.4%) preferred to walk as compared to married users. It was found that married users preferred to use drop-off and park and ride mode due to family commitment and easiness in mobility. Interestingly, students were found to be the majority users of all the access modes except for park and ride mode. This is probably because some of the students did not have a driving license and prefer to be dropped off at rail station by their family. Additionally, the lower income level was the majority users of bus and walking mode. This is due to cheaper bus fare and majority of them stayed near residential areas of access distance below 500m. Interestingly, all of the frequent rail users have access to vehicle either their own vehicle or their household vehicles. About 18.8% of them have more than one vehicle per household. As for the purpose of travel, as expected, more than half of the respondents use rail transit for work trips as compared to other purposes. With respect to different access modes, majority of the frequent rail users travelled between 10-11 trips per week, which indicate that most of the users are working or studying for 5 days a week.

For frequent rail users who access rail station by walking, additional questions on the characteristics of the walking route that they experienced from home to rail station were included in this study. However, from 112 of frequent rail users who walk to reach rail station from home, only 65 or 58.0% of them completed the related questions. The input on walking route characteristics is significant in order to obtain a general idea on the current walkway condition from frequent rail users' point of view. Later on, input from the analysis could be embedded in designing a proper walkway for pedestrians to access rail station from home. The walking route characteristics experienced by frequent rail users who walk to reach rail station from home was tabulated in Table 4.35. The walking route characteristics measurement was adapted from Walking Accessibility Model (WAM) by Wibowo, (2005).

Table 4.35: Walking Route Characteristics

Route characteristic *1.No. of roads that you have to cross*	**Frequency (Percentage)**	**Route characteristic** *2. Total delay time due to road crossing (minutes)*	**Frequency (Percentage)**
0	17 (26.2%)	0	*20 (30.7%)*
1	*22 (33.8%)*	1	11 (16.9%)
2	15 (23.1%)	2	5 (7.7%)
3	5 (7.7%)	3	5 (7.7%)
4	4 (6.2%)	4	1 (1.5%)
7	1 (1.5%)	5	12 (18.5%)
10	1 (1.5%)	10	8 (12.3%)
		15	3 (4.6%)
Total	65 (100.0%)	Total	65 (100.0%)

Route characteristic	**Frequency (Percentage)**			**Total Frequency/ (Total Percentage)**
	Yes	**No**	**Some**	
3. Zebra crossing/ Pedestrian bridges/ tunnel	20 (30.8%)	*35 (53.8%)*	10 (15.4%)	65 (100)
4. Crowded walkways	12 (18.5%)	*38 (58.5%)*	15 (23.1%)	65 (100)
5. Vulnerable route	21 (32.3%)	*25 (38.5%)*	19 (29.2%)	65 (100)
6. Risk of traffic accident	18 (27.7%)	*32 (49.2%)*	15 (23.1%)	65 (100)
7. Too many steps or slopes to climb	16 (24.6%)	*27 (41.5%)*	22 (33.8%)	65 (100)
8. Weather protection	18 (27.7%)	*31 (47.7%)*	16 (24.6%)	65 (100)

The frequency and percentage value for each walking route characteristics were depicted in Table 4.35. Majority of frequent rail users (33.8%) were reported that they have to cross the road at least once while walking from home to the rail station. Although they have to cross the road while accessing rail station, majority of them (30.7%) reported that no time delay occurred due to road crossing. It was also discovered that majority of the pedestrian reported that there was no zebra crossing/pedestrian bridges/ tunnel, no vulnerable route provided, no weather protection along the walkway and too many steps or slopes to climb. The lack of access facilities along the walkway will be a deterrent to pedestrians or walkers if no necessary action taken. However, 49.2% of them perceived their walking route as low risk of accident. Through cross-tabulation, more than half (64.6%) of them were light rail transit system (LRT) users, followed by KTM Komuter system (27.7%) users, whereas 6.2% of them refused to give information on the type of rail transit system that they used daily and 1.5% of them used Monorail system. Interestingly, About 25.7% of LRT users stated that there were too many steps or slopes to climb along the walkways to reach rail station and 88.9% of KTM Komuter users reported that there are no weather protection facilities provided along the walkways. It was also highlighted in the Urban Rail Development Plan (Land Public Transport Commission, 2013b), which stated that inaccessibility from the surrounding areas resulted in low daily frequencies and slow journey times of KTM Komuter system. The comprehensive planning and action should be taken to assess current facilities, feeder services as well as local access by all modes (Land Public Transport Commission, 2013). It was envisaged that the greater use of KTMB stations would encourage Transit Oriented Developments (TODs) to be developed along the corridor and at the same time will develop local areas around the stations. However, in order to obtain more reliable and trustworthy findings, more samples from those respondents walking mode should be collected. The Importance-Performance analysis with average and standard deviation of the importance and satisfaction indicators for each access mode are discussed and presented in the following sub-sections.

4.9.1 Importance-Performance Analysis for Walking Mode

The purpose of I-S Model for the Traditional Importance-Performance Analysis (IPA) for walking mode accessibility indicators is to point out the areas or zones where improvements would have the greatest influence on improving satisfaction of the entire system (Yang, et al. 2011). In addition, it is possible to identify indicators or parameters that are the most important to the frequent rail users, as well as those that have poor performance, i.e. the indicators that should be improved immediately (Matzler et al. 2003; Deng et al. 2008; Grujicic et al.2014). The I-S Model was presented as a two-dimensional matrix in the coordinate system (x-axis importance, y-axis satisfaction), which forms four-quadrants. Based on the literature, the four quadrants were referred as Quadrant I: Keep up the good work, Quadrant II: Possible Overkill, Quadrant III: Low Priority and Quadrant IV: Concentrate Here as depicted in Figure 4.24 (Deng et al.2008; Wu & Shieh 2009). After plotting all the indicators, the decision maker and service operator will then be able to identify the strengths and drawback of the system.

The reliabilities of satisfaction and importance of walking mode are measured by Cronbach’s alpha (α) with the values of 0.904 and 0.919, respectively. The differences between these two figures are small, within the range of 0.90 ~ 0.92, which indicate that the questionnaire was highly reliable. Walking mode accessibility indicators for importance levels as well as satisfaction (performance) levels were rated base on five point Likert scale ranging from 1- *not at all important* to 5-*extremely important*. The results for all 10 indicators (W1 to W10) in terms of the I-S Model for walking mode were presented in Table 4.36. The quadrants or zones of which the walking mode accessibility indicators are fall into were presented in Figure 4.56.

Table 4.36: The Importance and Satisfaction Relative Value of the Walking Mode

Walking Accessibility Service Indicators	Importance		Satisfaction		Quadrants/ Zones
	Average	Std. Deviation	Average	Std. Deviation	
W1. Walking distance from home to station (access distance)	4.38	0.850	3.76	1.068	QI: Keep up the good work
W2. Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)	4.43	0.794	3.50	1.176	QIV: Concentrate here
W3. Number of road crossings and delays	4.29	0.934	3.71	1.001	QII: Possible overkill
W4. Number of stairs or slopes to climb (ascending and descending steps).	4.02	0.968	3.33	1.017	QIII: Low priority
W5. Crowded along walkways	4.09	1.062	3.60	1.009	QII: Possible overkill
W6. Risk of traffic accident	4.51	0.859	3.64	1.089	QI: Keep up the good work
W7. Directness of walking path	4.30	0.889	3.68	0.970	QII: Possible overkill
W8. Walkaway characteristic (width, surface quality, surface material, etc.)	4.38	0.862	3.60	1.009	QI: Keep up the good work
W9. Facilities toward people with disabilities	4.58	0.718	3.21	1.274	QIV: Concentrate here
W10. Security along the way to station	4.69	0.601	3.55	1.097	QIV: Concentrate here
Average	**4.37**	**0.85**	**3.56**	**1.07**	

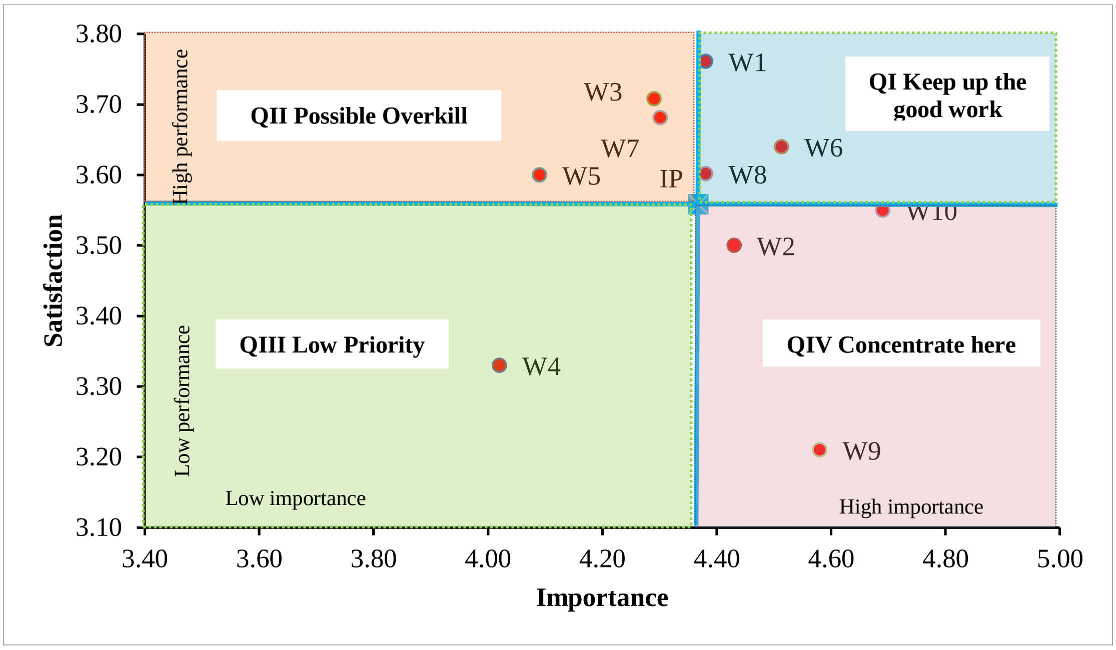

Figure 4.56: Walking Mode Accessibility Indicators Distributed Per Quadrants

As tabulated in Table 4.36, the average score for walking mode accessibility ‘importance’ across all 10 indicators is 4.37 and that for satisfaction is 3.56. As shown in Figure 4.56 (Traditional IPA), there were three indicators, namely W1: Walking distance from home to station, W6: Risk of traffic accident and W8: Walkaway characteristics, were located in Quadrant QI: Keep up the good work, which referred as high importance and high level of satisfaction. There were three indicators located in Quadrant QII: Possible Overkill, namely, W3: Number of road crossings and delays, W5: Crowded along walkways and W7: Directness of walking path. The indicators located in this quadrant achieved high satisfaction level but low importance level. For Quadrant III: Low Priority, there was only one indicator located in this quadrant, namely, W4: Number of stairs or slopes to climb (ascending and descending steps). The number of stairs or slopes to climb from frequent rail users home to station featured as both low satisfaction and low importance which therefore implied that there is no additional improvement required for this indicator or attribute. Interestingly, frequent rail users who are walking from home to rail station implied that there were three indicators that are of great importance but have poor performance (lower satisfaction). These three indicators, namely, W2: Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.), W9: Facilities toward people with disabilities and W10:Security along the way to station, were located in Quadrant IV: Concentrate here. The frequent rail users who are walking from home to station assessed these indicators as being highly importance to them, but of unsatisfactory performance. In other words, the indicators located in this quadrant should be emphasized and urgently improved because of the low user's satisfaction but identified as highest priority to frequent rail users who is walking from home to station.

In order to prevent a mistake in selecting and considering walking mode indicators that should be prioritized, confidence interval of 95% was applied in this study. As discussed earlier, IPA with confidence interval was applied in this study in order to make IPA more effective. The IPA integrated with confidence intervals shows the range in which the population indicators is likely. In this study, the confidence interval was stated at the 95% confidence level which means that there is 95% confidence level that the similar constructed interval will contain the indicators that is to be estimated. The relationship between 10 walking accessibility indicators and confidence intervals with equal population variances assumption and unequal population variances assumption are shown in Figure 4.57 and 4.58. In addition, the summary of traditional IPA results (Figure 4.24) and IPA results under different population variances assumption with 95% confidence intervals is presented in Table 4.37.

Table 4.37: The Comparison and Summary of Walking Accessibility Indicators for Traditional IPA and IPA with 95% Confidence Intervals under Different Population Variances Assumptions

Walking Accessibility Indicators	**Traditional IPA**	**IPA with Equal Population Variances Assumption**	**IPA with Unequal Population Variances Assumption**
W1. Walking distance from home to station (access distance)	QI: Keep up the good work	Undetermined	QI: Keep up the good work
W2. Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)	QIV: Concentrate here	Undetermined	QIV: Concentrate here
W3. Number of road crossings and delays	QII: Possible overkill	Undetermined	QII: Possible overkill
W4. Number of stairs or slopes to climb (ascending and descending steps).	QIII: Low priority	QIII: Low priority	QIII: Low priority
W5. Crowded along walkways	QII: Possible overkill	Undetermined	QII: Possible overkill
W6. Risk of traffic accident	QI: Keep up the good work	Undetermined	QI: Keep up the good work
W7. Directness of walking path	QII: Possible overkill	Undetermined	QII: Possible overkill
W8. Walkaway characteristic (width, surface quality, surface material, etc.)	QI: Keep up the good work	Undetermined	QI: Keep up the good work
W9. Facilities toward people with disabilities	QIV: Concentrate here	QIV: Concentrate here	QIV: Concentrate here
W10. Security along the way to station	QIV: Concentrate here	Undetermined	Undetermined

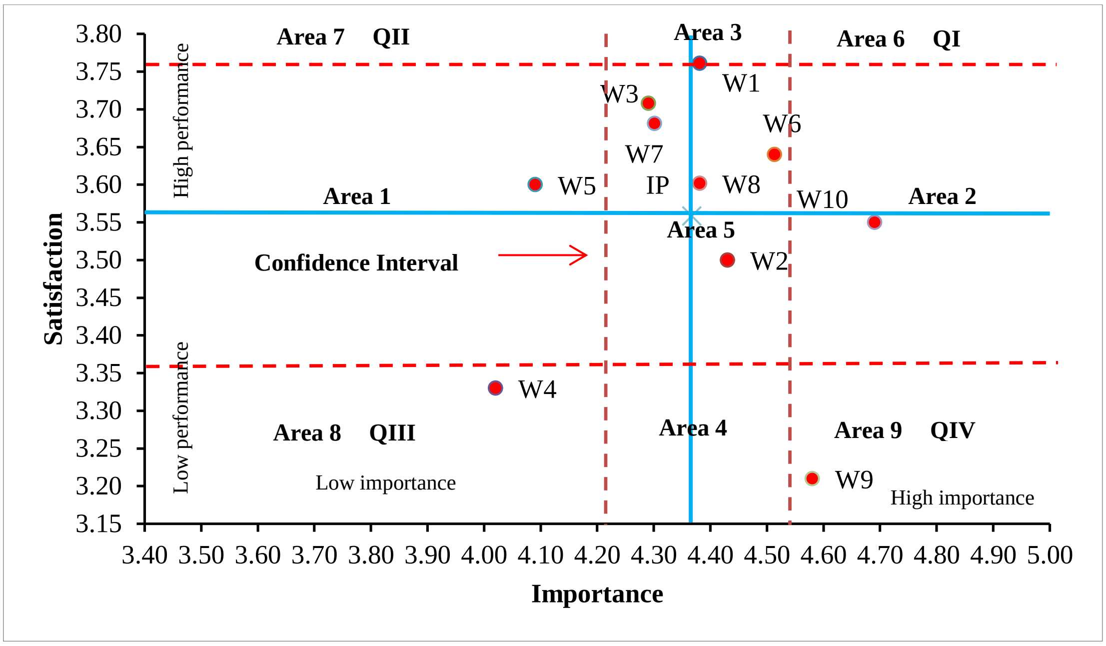

Figure 4.57: The IPA Plot for 95% Confidence Intervals with Equal Population Variances Assumption of Walking Accessibility Indicators

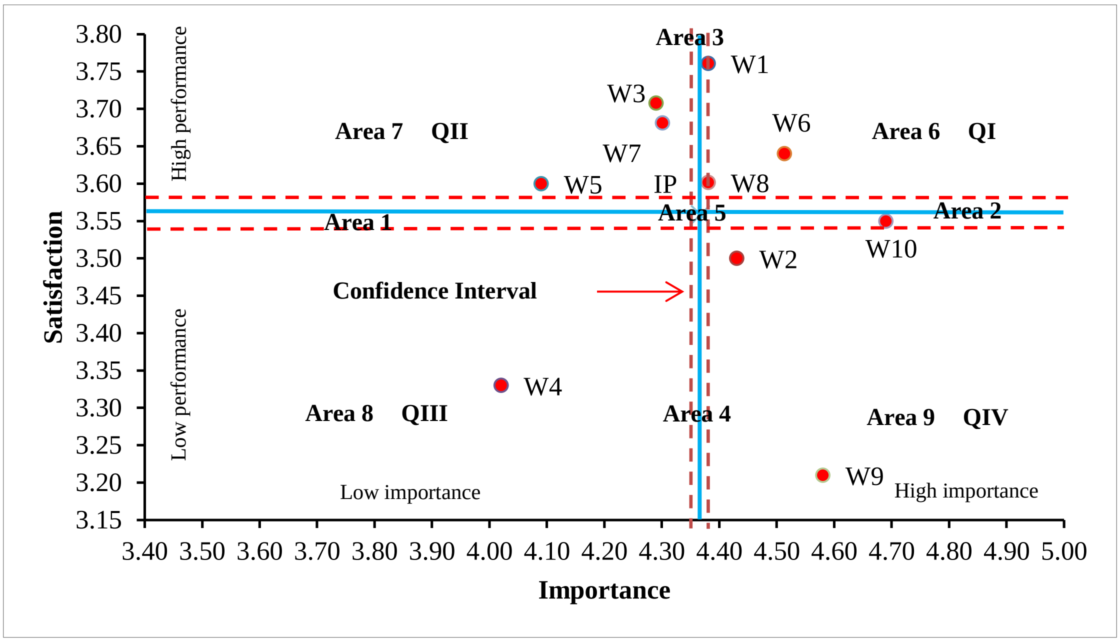

Figure 4.58: The IPA Plot for 95% Confidence Intervals with Unequal Population Variances Assumption of Walking Accessibility Indicators

The four quadrants IPA plot for 95% Confidence Intervals with Equal and Unequal Population Variances Assumption were divided into nine areas by four dotted lines (lower and upper confidence limits) as depicted in Figure 4.57 and Figure 4.58. From the analysis, there were eight walking accessibility indicators located in undetermined or confidence interval areas. The walking accessibility indicators under quadrant , QIV are W1 (Walking distance), W3 (Road crossings and delays), W6 (Traffic accident risk), W7 (Walking path directness), W8 (Walkaway quality) and W10 (Security along the way to station). It also noted that indicator W2 (Walking comfort) was in the confidence interval area, which means that there is a probability that analysis on a new sample will not allocate this indicator in the quadrant QIV. Interestingly, indicator W9 (Disable facilities) and W4 (Number of stairs or slopes to climb, ascending and descending steps) remained in quadrant QIV with a probability of 95%. However, with respect to sampling variability, most of the indicators were located in undetermined areas when the population variances assumed to be equal.

Based on Figure 4.58, the IPA Plot for 95% confidence intervals with unequal population variances assumption showed that only indicator W10: Security along the way to station, was located in undetermined area (Area 2). As compared to traditional IPA result, indicator W10 was located in quadrant Q1: Keep up the good work. In addition, other walking accessibility indicators displayed similar results when compared to traditional IPA. Therefore, two walking accessibility indicators, namely W2: Walking comfort and convenient and W9: Facilities toward people with disabilities, was proposed as priority indicators that need to be improved by the decision makers and service operators as it indicated the lack of access facilities for disable persons in KV. The current situation shows that rail service operators were committed in providing high quality accessible facilities at station for disable commuters to use. For instance, the LRT's service operator, namely, RapidKL had provided disable parking space, Priority Lane

Wide gate, accessible lift with tactile (embossed and Braille) lift buttons, disable accessible toilets, handrails at the entrance/exit ramps and many other facilities. However, it was proposed that the provided accessible facilities at station may not be fully utilized if accessibility elements (access mode, walking facilities, park and ride and etc.) to reach rail station are not improved. For instance, there was minimize facilities for wheelchair users and no blind guided walkways were provided within the average walking distance i.e. 400m (Land Public Transport Commission, 2013).

4.9.2 Importance Performance Analysis for Taxi Mode

It was identified that there were over 30000 licensed taxis operating in Klang Valley (Land Public Transport Commision, 2013c). As compared to other international cities, it was found that the provision of taxis in the Klang Valley (KV) compared to the population is on the high side (Land Public Transport Commision, 2013c). In this section, the Traditional Importance-Performance Analysis (IPA) and IPA results under different population variances assumption with 95% confidence intervals for taxi mode will be presented and discussed. For taxi mode, eight indicators were investigated. The responses for this analysis were obtained from 13.4% of frequent rail users who used taxi as their access mode to reach rail station. Similar to walking mode, the IPA Model was presented as a two-dimensional matrix in the coordinate system (x-axis importance, y-axis satisfaction), which forms four-quadrants, namely Quadrant I: Keep up the good work, Quadrant II: Possible Overkill, Quadrant III: Low Priority and Quadrant IV: Concentrate Here. After plotting all the taxi mode indicators, the decision maker and service operator are will then be able to determine the strengths and drawback of the taxi services as access mode to rail station.

The reliabilities of satisfaction and importance for taxi accessibility indicators were measured by Cronbach's alpha (α) with the values of 0.84 and 0.60, respectively. The taxi mode satisfaction indicators showed high reliability whereas taxi accessibility importance indicators showed moderate reliability (Hinton et al., 2004). Taxi accessibility indicators for importance levels as well as satisfaction (performance) levels were rated on a five point Likert scale ranging from 1- *not at all important* to 5-*extremely important*. The results for all 8 indicators (T1 to T8) in terms of the I-S Model for taxi mode were presented in Table 4.38 and Figure 4.59. The quadrants or zones of which the taxi accessibility indicators fall into were also presented.

Table 4.38: The Importance and Satisfaction Relative Value of Taxi Accessibility Indicators

Taxi Accessibility Indicators	**Importance**		**Satisfaction**		**Quadrants/ Zones**
	Average	**Std. Deviation**	**Average**	**Std. Deviation**	
T1. Access fare from home to station.	4.36	0.61	3.07	0.99	QIV: Concentrate Here
T2. Access time from home to station.	4.56	0.50	3.11	0.86	QIV: Concentrate Here
T3. Service reliability of the taxi	4.22	0.77	3.24	0.98	QII: Possible Overkill
T4. Convenient and comfort in the taxi	4.16	0.77	3.49	0.92	QII: Possible Overkill
T5. Security concerns and safety issues	4.71	0.46	3.40	0.75	QI: Keep up the good work
T6. Customer service and driver behaviour	4.20	0.73	3.24	0.77	QII: Possible Overkill
T7. Information on driver registration and passenger service vehicle.	3.84	0.90	3.47	0.89	QII: Possible Overkill
T8. Facilities toward people with disabilities.	4.47	0.81	2.93	0.96	QIV: Concentrate here
Average	4.31	0.69	3.24	0.89	

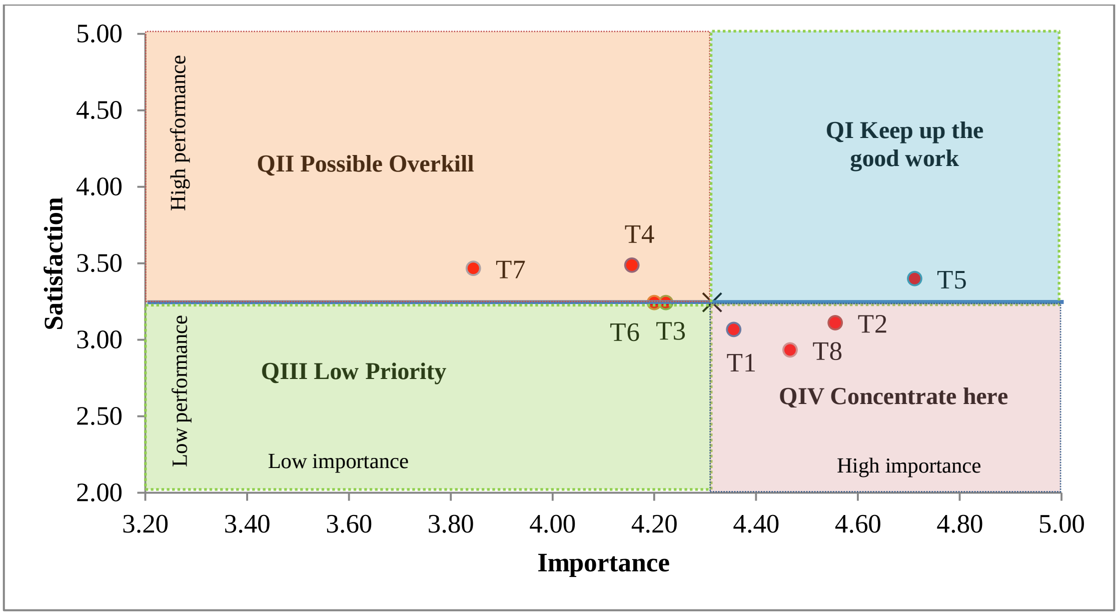

Figure 4.59: Taxi Accessibility Indicators Distributed per Quadrants

As tabulated in Table 4.38, the average importance score for taxi mode accessibility across all eight indicators was 4.31 and average satisfaction score was 3.24. In Traditional IPA as shown in Figure 4.59, there was only one indicator, namely, T5: Security concerns and safety issues located in Quadrant QI: Keep up the good work, which referred as high importance and high level of satisfaction. There were two indicators located in Quadrant QII: Possible Overkill, namely, T4: Convenient and comfort in the taxi and T7: Information on driver registration/ passenger service vehicle. The indicators located in this quadrant achieved high satisfaction level but low importance level. What is interesting in this finding is there were two indicators located in the demarcation line of quadrant QII: Possible Overkill and quadrant QIII: Low Priority. The two indicators were T3: Service reliability of the taxi and T6: Customer service and driver behaviour. It was in ambivalent state whether to consider this indicator as in quadrant QII or QIII because the satisfaction value was at the demarcation line. However, this indicator was considered located in quadrant QII: Possible Overkill since the indicator reached the average satisfaction level of all taxi mode indicators. Interestingly, frequent rail users who used taxi from home to rail station implied that there were three indicators that are of great importance but have poor performance (lower satisfaction). The three indicators were, T1: Access fare from home to station, T2: Access time from home to station and T8: Facilities toward people with disabilities which was located in Quadrant IV: Concentrate here. The frequent rail users who are using taxi from home to station assessed these indicators as being highly importance to them, but of unsatisfactory performance. In other words, the indicators located in this quadrant should be emphasized and urgently improved because of the low user's satisfaction but has been identified as highest priority to frequent rail users who is using taxi from home to station. Results from the analysis specified that by emphasizing the indicators in quadrant, QIV: Concentrate here, it will enhance taxi mode services and at the same time improving the rail transit service in KV from frequent rail transit users point of view. However, there is an argument whether the investigating of new sample will accomplish identical findings.

In order to prevent a mistake in selecting and considering taxi mode indicators that should be prioritized, confidence interval of 95% was applied in this study. The IPA integrated with confidence intervals showed the range in which the population indicators is likely. The confidence interval of 95% means that there is 95% confidence level that the similar constructed interval will contain the indicators that is to be estimated. The relationship between eight taxi accessibility indicators and confidence intervals with equal population variances assumption and unequal population variances assumption are shown in Figure 4.60 and 4.61. In addition, the summary of traditional IPA results (Figure 4.59) and IPA results under different population variances assumption with 95% confidence intervals is presented in Table 4.39.

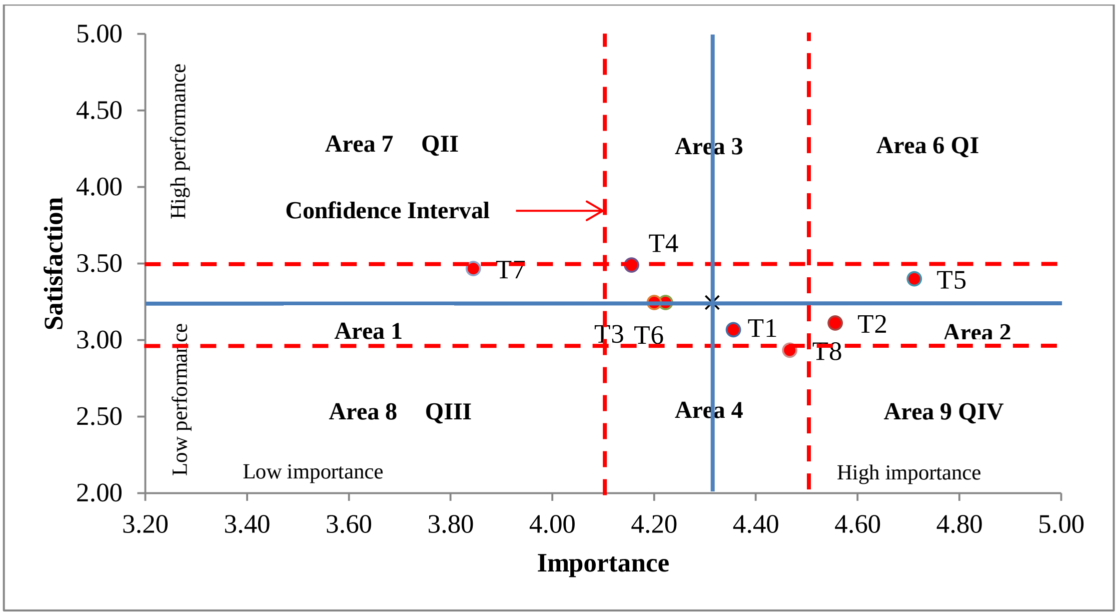

Figure 4.60: The IPA Plot for 95% Confidence Intervals with Equal Population Variances Assumption of Taxi Accessibility Indicators

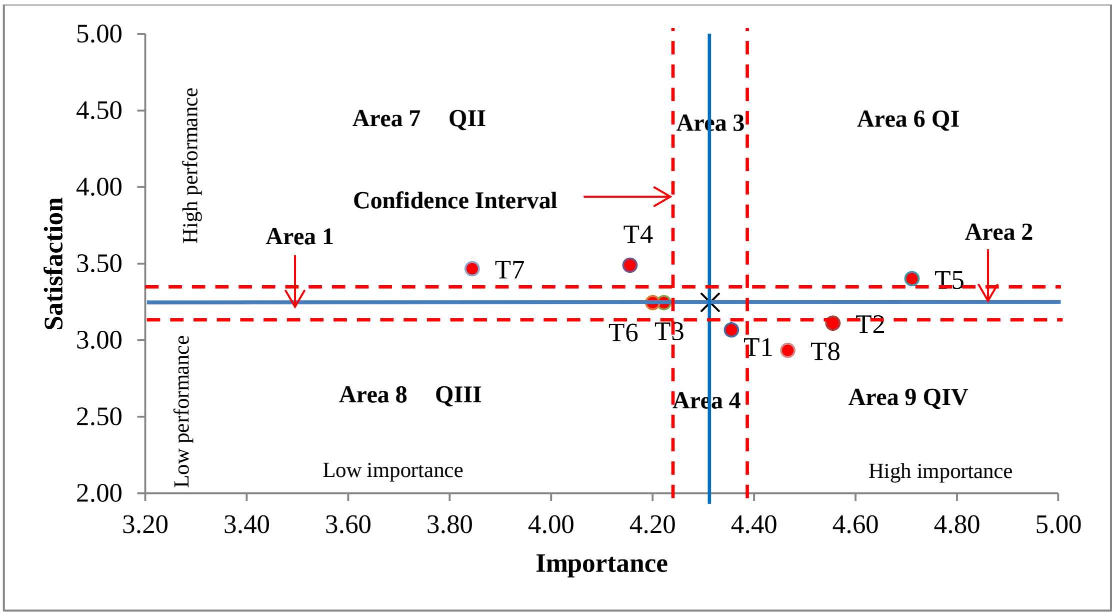

Figure 4.61: The IPA Plot for 95% Confidence Intervals with Unequal Population Variances Assumption of Taxi Accessibility Indicators

Table 4.39: The Comparison and Summary of Taxi Accessibility Indicators for Traditional IPA and IPA with 95% Confidence Intervals under Different Population Variances Assumptions

Taxi Accessibility Indicators	Traditional IPA	IPA with Equal Population Variances Assumption	IPA with Unequal Population Variances Assumption
T1. Access fare from home to station.	QIV: Concentrate Here	Undetermined	Undetermined
T2. Access time from home to station.	QIV: Concentrate Here	Undetermined	QIV: Concentrate here
T3. Service reliability	QII: Possible Overkill	Undetermined	Undetermined
T4. Convenient and comfort in the taxi	QII: Possible Overkill	Undetermined	QII: Possible Overkill
T5. Security concerns and safety issues	QI: Keep up the good work	Undetermined	QI: Keep up the good work
T6. Customer service and driver behaviour	QII: Possible Overkill	Undetermined	Undetermined
T7. Information on driver registration and passenger service vehicle.	QII: Possible Overkill	Undetermined	QII: Possible overkill
T8. Facilities toward people with disabilities.	QIV: Concentrate here	Undetermined	QIV: Concentrate here

Similar as walking accessibility indicators analysis, the four quadrants IPA plot for 95% Confidence Intervals with Equal and Unequal Population Variances Assumption were divided into nine areas by four dotted lines (lower and upper confidence limits) as depicted in Figure 4.60 and Figure 4.61. Based on Figure 4.60, the IPA Plot for 95% confidence intervals with equal population variances assumption showed that all taxi accessibility indicators were located in confidence interval area or undetermined areas because of sampling variability. The taxi accessibility indicators that have the possibility to be located in the quadrant QIV are indicators T3 (Service reliability of the taxi), T4 (Convenient and comfort in the taxi), T5 (Security concerns and safety issues) and T6

(Customer service and driver behaviour). It can also be depicted that indicator T1 (Access fare from home to station), T2 (Access time from home to station) and T8 (Facilities toward people with disabilities) was in the confidence interval area, which means that there is a probability that analysis on a new sample will not allocate this indicator in the quadrant QIV. It was also found that there are no taxi accessibility indicators remained in quadrant QIV with a probability of 95%.

On the contrary, the IPA Plot for 95% confidence intervals with unequal population variances assumption (Figure 4.61), showed different findings as compared to IPA Plot for 95% confidence intervals with equal population variances assumption (Figure 4.28). It was indicated that two taxi accessibility indicators, namely, T2 (Access time from home to station) and T8 (Facilities toward people with disabilities) remained in quadrant Q4 with a probability of 95%. This result was similar with Traditional IPA results which discussed previously. It was indicated that attributes or indicators located in quadrant QIV (satisfaction is low and importance is high) require immediate attention and should be prioritized. The inability to determine the major weakness will deter frequent rail users to use taxi as their access mode and indirectly resulting in low commuters satisfaction (Deng et al., 2008). From the finding, frequent rail users who are used to access rail station from home highlighted access time as the indicator that should be prioritized for improvement so they will continue using rail consistently. The parallel issue with related to taxi access time is taxi waiting time which was not addressed in this study. Several researches identified waiting time as one of the most influential factors affecting the demand for public transportation (St-Louis et al., 2014; Wardman, 2014; Fan et al., 2016). The elasticity of demand with respect to time is recorded to be higher than the elasticity of demand with respect to fare, which means commuters are more sensitive towards changes in waiting time rather than change in the fare. It was suggested that recollecting the new data should be carried out by including the taxi waiting time indicator in order to obtain more comprehensive and reliable findings. In addition, another important determinant of taxi demand is service quality. It was indicated that the commuters are more responsive towards service quality as compared to fare (Land Public Transport Commission, 2013c). Commuters are willing to pay more for their travel as long as the service quality meets their needs and expectation. The Pemandu Q3 2010 NKRA Baseline Survey showed that about 89.0% of taxi users indicated the taxi service as satisfactory, and ranked better than bus and KTM Komuter service (Land Public Transport Commission, 2013c).However, the survey was conducted in year 2010 and the survey was conducted only to service users. It will be more comprehend to understand the satisfaction levels across wider population by conducting public attitude surveys with both service and non- service users in order to understand satisfaction levels across the wider population. Based on current situation, there are more than 37,000 taxis in the Klang Valley (KV) (Land Public Transport Commission, 2013), in which according to Land Public Transport Commission (SPAD) is too big for the city. Despite of huge numbers of taxis, there are many issues and complaints on taxis service quality from the locals as well as tourists (Lee, 2013; A. Jalil Hamid, 2015; Chan, 2016). Among the complaints were poor customer service quality, unkempt vehicles, hostile drivers, decrepit vehicles, drivers refused to serve congested destinations, and, choosing the destination based on the driver's own needs, overcharging, and refused to use meter (Lee, 2013; Chan, 2016; Ruban, 2016). Whereas, among the taxi operators and drivers concerned were there was no subsidy or allowance for natural gas (NG) installation in the taxis, bad treatment from regulators and enforcement officers as well as the low meter charges and higher maintenance cost (Tan, 2014).

In relation to this study, it was showed that there were three indicators, namely, T1 (Access fare from home to station), T3 (Service reliability) and T6 (Customer service and driver behaviour) remained in confidence interval areas which referred as “undetermined”. It was proposed that further investigation on these three indicators should be carried out to new samples in order to ensure the priority level of this indicators and the location of these indicators in IPA analysis. However, indicator T5 (Security concerns and safety issues) was located in quadrant QI: Keep up the good work, similar to Traditional IPA findings.

4.9.3 Importance Performance Analysis for Bus Mode

In Bus Transformation Plan, (Land Public Transport Commission, 2013d), it was estimated that there are a total of 13 main bus operators plus a handful of smaller operators who operate on the periphery of the urban areas. It was found that 70% of stage bus annual ridership in Malaysia were from Kuala Lumpur, which was the busiest area in KV region. In Bus Transformation Plan prepared by Land Public Transport Commission (LPTC), it was revealed that the current method of bus operation services in KV faced severe service quality, delivery and reliability issues. In addition, several key issues which were identified by the public included waiting time, travel time, accessibility, punctuality, bus condition etc. Therefore, the Land Public Transport Commission has developed the bus service standards measurement in terms of service quality, comfort, safety and environment attributes. The bus service standards measurements were applied on the bus operations, vehicles and infrastructure provision. Apart from improvement of overall bus service performance in KV, Bus Transformation Plan (Land Public Transport Commission, 2013d) was also focused on the development of localised bus service network that would operate as a feeder bus service network in order to meet the growing travel demands in KV and at the same time enhancing the existing and current rail network system. It was believed that the provision of tracked existing transit, for instance, LRT or a new MRT system, supplemented by feeder bus services will offer significantly faster and more reliable travel times. Based on 2013 data, (Land Public Transport

Commission, 2013d), 61.0% of the KV region's population live within 400 metres of a bus service. It was targeted in National Key Results Areas (NKRA) to increase this value to 70% with additional bus services which will be introduced in 2012 (Land Public Transport Commission, 2013d). In this study, it was found that all the respondents used feeder bus as access mode to reach rail station from home. The feeder buses were provided by Rapid KL, which was one of the Prasarana Malaysia subsidiaries companies.

In this section, the Traditional Importance-Performance Analysis (IPA) and the IPA results under different population variances assumption with 95% confidence intervals for bus mode will be presented and discussed. For bus mode, eight indicators were investigated. The responses for this analysis were obtained from 16.1% of frequent rail users who used bus as their access mode to reach rail station. Similar to taxi mode, the IPA Model was presented as a two-dimensional matrix in the coordinate system (x-axis importance, y-axis satisfaction), which forms four-quadrants, namely Quadrant I: Keep up the good work, Quadrant II: Possible Overkill, Quadrant III: Low Priority and Quadrant IV: Concentrate Here. After plotting all the bus mode indicators, decision maker and service operator will then able to determine the strengths and drawback of the bus services as access mode to rail station. The reliabilities of satisfaction and importance for bus accessibility indicators were measured by Cronbach's alpha (α) with the values of 0.90 and 0.85, respectively. It was indicated that the bus accessibility indicators for satisfaction and importance showed high reliability (Hinton et al., 2004). The bus accessibility indicators for importance levels were rated on a five point Likert scale ranging from 1- *not at all important* to 5-*extremely important*. Whereas, satisfaction (performance) levels were rated on a five point Likert scale ranging from 1- *not at all satisfied* to 5-*extremely satisfied*. The results for all 8 indicators (B1 to B8) in terms of the I-S Model for bus mode were presented in Table 4.40 and Figure 4.62. The quadrants or zones of which the bus accessibility indicators are fall into were also presented.

Table 4.40: The Importance and Satisfaction Relative Value of Bus Accessibility Indicators

Bus Accessibility Indicators	Importance		Satisfaction		Quadrants/ Zones
	Average	Std. Deviation	Average	Std. Deviation	
B1. Access fare from home to station.	4.44	0.691	3.81	1.100	QI: Keep up the good work
B2. Access time from home to station.	4.41	0.630	3.48	0.966	QIV: Concentrate Here
B3. Service reliability of the bus.	4.30	0.838	3.19	1.183	QIII: Low Priority
B4. Convenient and comfort in the bus.	4.28	0.763	3.57	1.057	QII: Possible Overkill
B5. Security concerns and safety in the bus.	4.52	0.746	3.74	0.975	QI: Keep up the good work
B6. Customer service and driver behaviour	4.35	0.705	3.46	1.128	QIII: Low Priority
B7. Information on service schedule/maps at the bus stops.	4.39	0.712	3.43	1.268	QIII: Low Priority
B8. Facilities toward disabled passengers.	4.57	0.602	3.61	1.140	QI: Keep up the good work
Average	**4.41**	**0.711**	**3.54**	**1.102**	

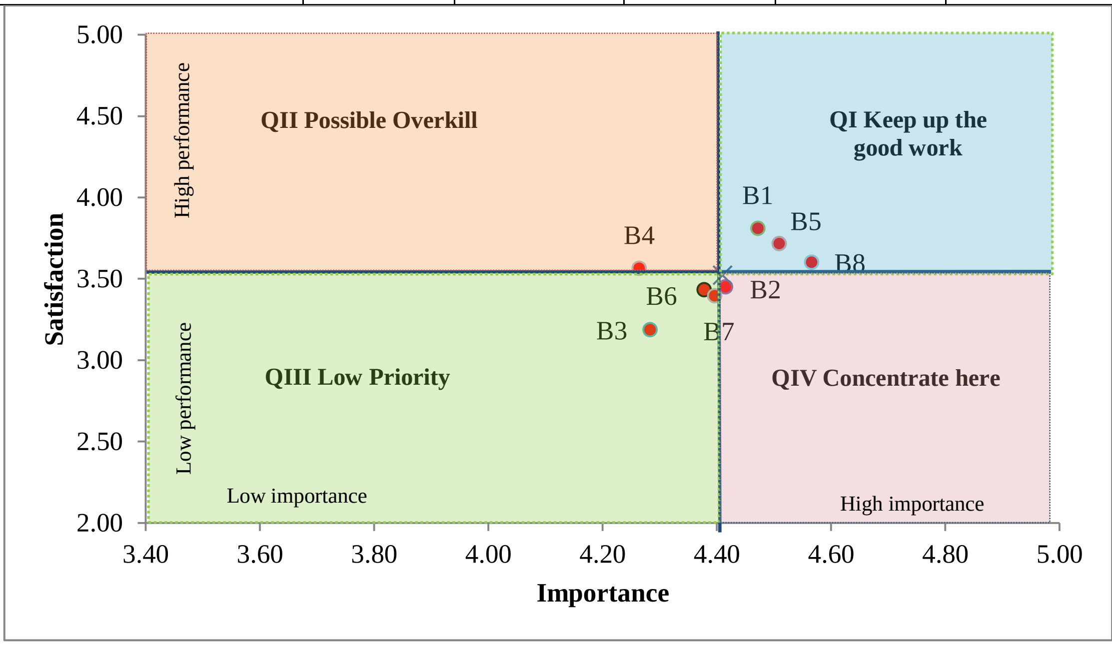

Figure 4.62: Bus Accessibility Indicators Distributed per Quadrants

As tabulated in Table 4.40, the average importance score for bus mode accessibility across all eight indicators was 4.41 and average satisfaction score was 3.54. In Traditional

IPA as shown in Figure 4.62, there were three indicators, namely, B1: Access fare from home to station, B5: Security concerns and safety and B8: Facilities toward disabled passengers located in Quadrant QI: Keep up the good work, which referred as high importance and high level of satisfaction. Interestingly, frequent rail users who used bus to reach rail station from home rated facilities performance for disabled peoples as slightly more than average as compared to walking and taxi mode users. This was possibly because of improvement on bus stop infrastructure and provision of related facilities which allowed step free access to vehicles as highlighted in Bus Transformation Plan (Land Public Transport Commission, 2013d).

It was discovered that only one indicator was located in Quadrant QII: Possible Overkill, namely, B4: Convenient and comfort in the bus. The indicator which located in this quadrant achieved high satisfaction level but low importance level. There were three indicators located in quadrant QIII: Low Priority. The three indicators were B3: Service reliability of the bus, B6: Customer service and driver behaviour and B7: Information on service schedule/maps at the bus stops. The indicators which located in Quadrant QIII were rated as low importance and low performance which do not require extra efforts to improve (Grujicic et al., 2014). Interestingly, frequent rail users who are using bus from home to rail station implied that there was only one indicator which of great importance but have poor performance (lower satisfaction). The indicator was B2: Access time from home to station which was located in Quadrant IV: Concentrate here. The frequent rail users who are using bus from home to station assessed these indicators as being highly importance to them, but of unsatisfactory performance. In other words, the indicators located in this quadrant should be emphasized and urgently improved because of the low user's satisfaction and has been identified as highest priority to frequent rail users who is taking bus from home to station. Results from the analysis specified that by emphasizing on the indicators in quadrant, QIV: Concentrate here, may enhance the feeder bus services and at the same time improving the rail transit service in KV from frequent rail transit users point of view. However, there is an argument whether the investigating of new sample will accomplish identical findings (Wu & Shieh, 2009; Grujicic et al., 2014).

Similar to walking and taxi accessibility indicators, confidence interval of 95% was applied in this study to prevent a mistake in selecting and considering bus mode indicators that should be prioritized. The IPA integrated with confidence intervals showed the range in which the population indicators is likely. The confidence interval of 95% means that there is 95% confidence level that the similar constructed interval will contain the indicators that is to be estimated. The relationship between eight bus accessibility indicators and confidence intervals with equal population variances assumption and unequal population variances assumption are shown in Figure 4.63 and 4.64. In addition, the summary of traditional IPA results (Figure 4.62) and IPA results under different population variances assumption with 95% confidence intervals is presented in Table 4.41.

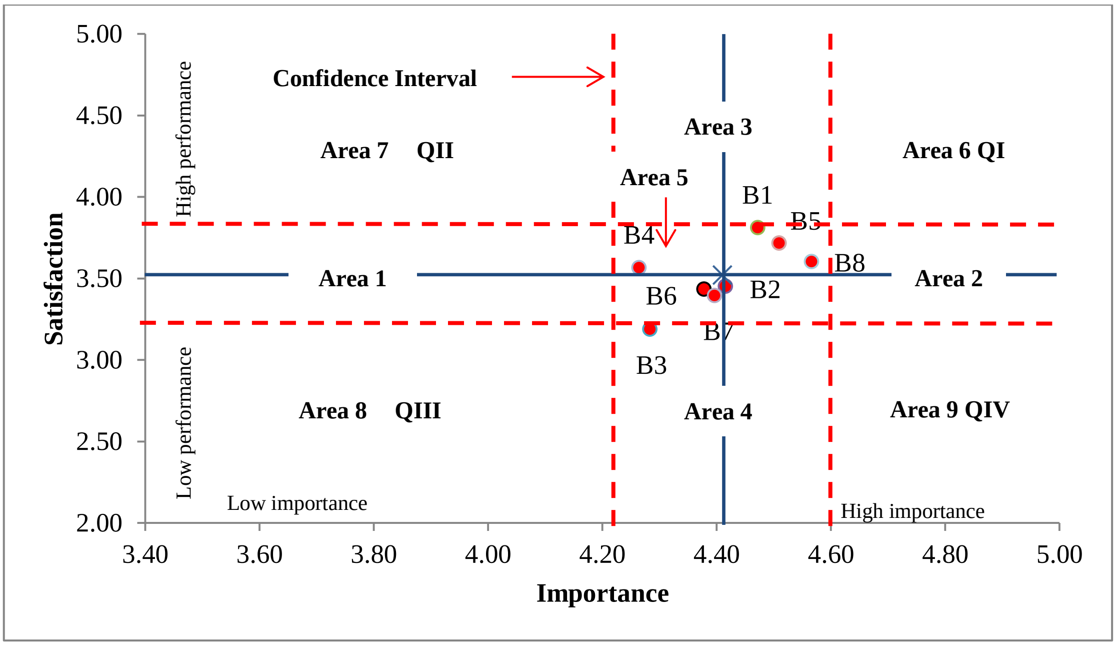

Figure 4.63: The IPA Plot for 95% Confidence Intervals with Equal Population Variances Assumption of Bus Accessibility Indicators

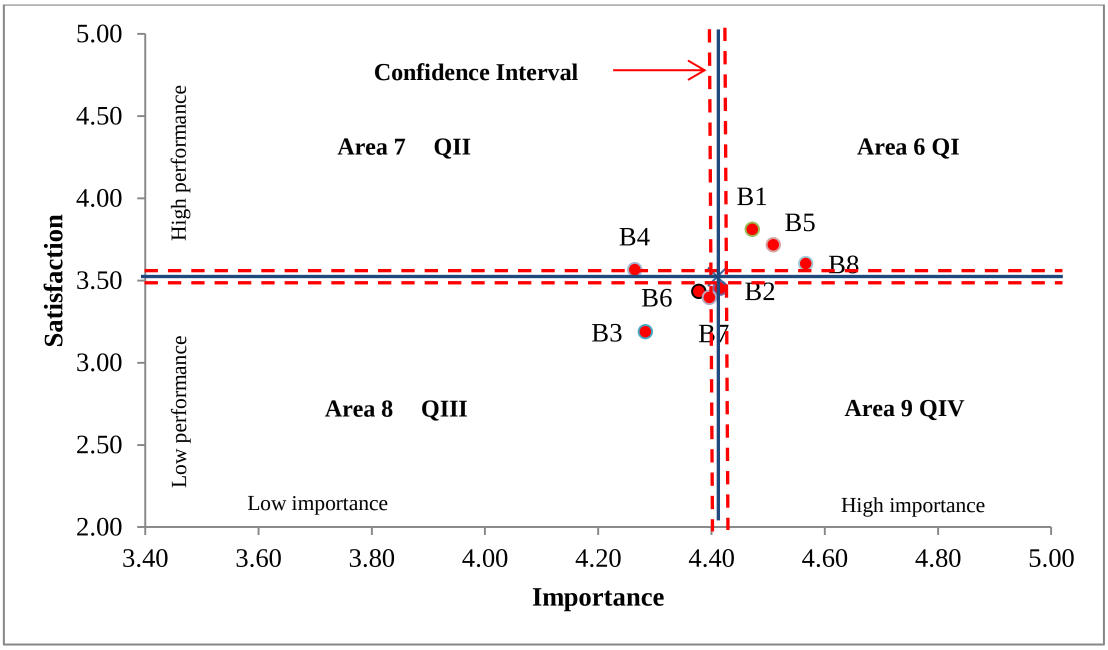

Figure 4.64: The IPA Plot for 95% Confidence Intervals with Unequal Population Variances Assumption of Bus Accessibility Indicators

Table 4.41: The Comparison and Summary of Bus Accessibility Indicators for Traditional IPA and IPA with 95% Confidence Intervals under Different Population Variances Assumptions

Bus Accessibility Indicators	**Traditional IPA**	**IPA with Equal Population Variances Assumption**	**IPA with Unequal Population Variances Assumption**
B1. Access fare from home to station.	QI: Keep up the good work	Undetermined	QI: Keep up the good work
B2. Access time from home to station.	QIV:Concentrate Here	Undetermined	Undetermined
B3. Service reliability of the bus.	QIII: Low Priority	Undetermined	QIII: Low Priority
B4. Convenient and comfort in the bus.	QII: Possible Overkill	Undetermined	QII: Possible Overkill
B5. Security concerns and safety in the bus.	QI: Keep up the good work	Undetermined	QI: Keep up the good work
B6. Customer service and driver behaviour	QIII: Low Priority	Undetermined	QIII: Low Priority
B7. Information on service schedule/maps at the bus stops.	QIII: Low Priority	Undetermined	QIII: Low Priority
B8.Facilities toward disabled passengers.	QI: Keep up the good work	Undetermined	QI: Keep up the good work

Similar to walking accessibility indicators analysis, the four quadrants IPA plot for 95% Confidence Intervals with Equal and Unequal Population Variances Assumption were divided into nine areas by four dotted lines (lower and upper confidence limits) as depicted in Figure 4.63 and Figure 4.64. Based on Figure 4.63, the IPA Plot for 95% confidence intervals with equal population variances assumption showed that all taxi accessibility indicators were located in confidence interval area or undetermined areas because of sampling variability. Interestingly, it was discovered that all the bus accessibility indicators have the possibility to be located in the quadrant QIV: Concentrate Here for the IPA Plot of 95% Confidence Intervals with Equal Population Variances Assumption. It was found that all of the indicators were in the confidence interval area, which means that there is a probability that analysis on a new sample will not allocate these indicators in their existing traditional IPA quadrants. It was also found that there is no taxi accessibility indicators remained in quadrant QIV with a probability of 95% Confidence Intervals with Equal Population Variances Assumption.

On the contrary, the IPA Plot for 95% confidence intervals with unequal population variances assumption (Figure 4.64), showed different findings as compared to IPA Plot for 95% confidence intervals with equal population variances assumption (Figure 4.63). However, the IPA Plot for 95% confidence intervals with unequal population variances assumption depicted similar findings as Traditional IPA Plot (Figure 4.62) except for indicator B2: Access time from home to station. It was proposed that in the IPA analysis of new samples, indicator B2: Access time from home to station has the potential to be located in quadrant QIV because it was located in confidence interval area. Looking back to Traditional IPA finding, indicator B2: Access time from home to station required immediate attention and should be prioritized because the indicator was located in quadrant QIV (satisfaction is low and importance is high). This finding was similar with taxi accessibility indicators analysis which also depicted access time from home to station as the priority attributes for improvement so they will continue to use rail consistently. This is because the inability to determine the major weakness will deter frequent rail users to use bus as their access mode and indirectly result in low commuters satisfaction (Deng et al., 2008).

4.9.4 Importance Performance Analysis for Park and Ride Mode

In this section, the Traditional Importance-Performance Analysis (IPA) and the IPA results under different population variances assumption with 95% confidence intervals for park and ride mode was presented and discussed. For park and ride mode, six indicators were investigated. The responses for this analysis were obtained from 19.7% of frequent rail users who used park and ride facilities as their access mode to reach rail station. The IPA Model was presented as a two-dimensional matrix in the coordinate system (x-axis importance, y-axis satisfaction), which forms four-quadrants, namely Quadrant I: Keep up the good work, Quadrant II: Possible Overkill, Quadrant III: Low Priority and Quadrant IV: Concentrate Here. After plotting all the park and ride indicators, it was proposed that a decision maker and service operator will then be able to determine the strengths and drawback of the park and ride facilities as access mode to rail station. The reliabilities of satisfaction and importance for park and ride indicators were measured by Cronbach's alpha (α) with the values of 0.82 and 0.81, respectively. It was indicated that park and ride indicators for satisfaction and importance showed high reliability (Hinton et al., 2004). The park and ride accessibility indicators for importance levels were also rated on a five point Likert scale ranging from 1- *not at all important* to 5-*extremely important*. Whereas, satisfaction (performance) levels were rated on a five point Likert scale ranging from 1- *not at all satisfied* to 5-*extremely satisfied*. The results for all six indicators (B1 to B8) in terms of the I-S Model for park and ride mode were presented in

Table 4.42 and Figure 4.65. The quadrants or zones of which the park and ride accessibility indicators are fall into were also presented.

Table 4.42: The Importance and Satisfaction Relative Value of Park and Ride Indicators

Park and Ride Accessibility Indicators	Importance		Satisfaction		Quadrants/ Zones
	Average	Std. Deviation	Average	Std. Deviation	
P1.Total fuel consumption from home to station.	4.09	1.034	3.33	1.141	QII: Possible Overkill
P2.Access time from home to station.	4.15	0.827	3.38	1.064	QII: Possible Overkill
P3.Availability of parking space at rail station	4.59	0.723	3.26	1.154	QI: Keep up the good work
P4.Parking fee in the station.	4.03	1.095	3.17	1.046	QIII: Low Priority
P5.Security concerns and safety issues (guarded parking space, etc.).	4.56	0.914	2.82	1.346	QIV: Concentrate here
P6. Facilities toward disabled peoples.	4.61	0.762	3.18	1.201	QIV: Concentrate here
Average	**4.34**	**0.892**	**3.19**	**1.159**	

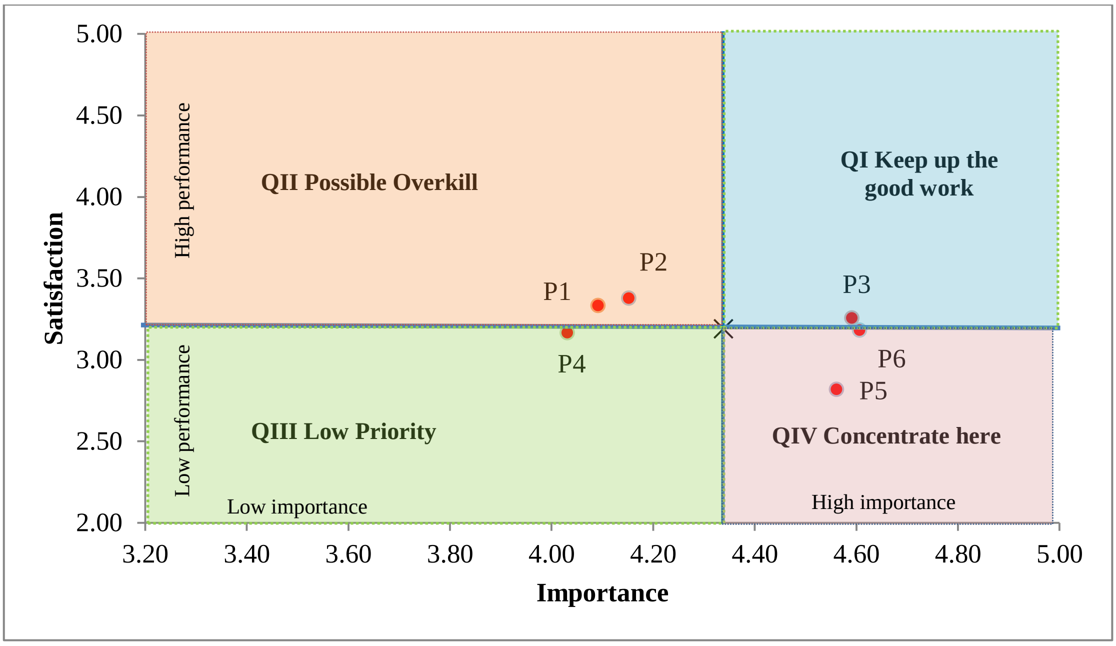

Figure 4.65: Park and Ride Accessibility Indicators Distributed per Quadrants

As tabulated in Table 4.42, the average importance score for park and ride mode accessibility across all six indicators was 4.34 and average satisfaction score was 3.19. In Traditional IPA as shown in Figure 4.65, there was only one indicator, namely, P3: Availability of parking space at rail station located in Quadrant QI: Keep up the good work, which referred as high importance and high level of satisfaction.

It was discovered that there were two indicators located in Quadrant QII: Possible Overkill, namely, P2: Access time from home to station and P1: Total fuel consumption from home to station. The indicator which located in this quadrant achieved high satisfaction level but low importance level. Grujicic et al. (2014) stated that the indicators fall into Quadrant II implied that resources allocated to these indicators are overly satisfied or in other words possibly over supplied and it was proposed that those resources should be assigned to other related indicators or attributes (Grujicic et al., 2014). In addition, Chen and Huang (2011) also stated that there is no particular actions needed with respect to the attributes that fall in Quadrant II unless there is pressure in cost which requires action. It was discovered that access time from home to station was not the crucial indicator to frequent rail users who used their private car to access rail station as compared to taxi and bus mode. This is probably because frequent rail users who used park and ride facilities used their own private transport and are flexible to plan their journey without waiting for public transport mode. In addition, the frequent rail users believed that the fuel consumption they used to reach rail station from home is affordable as compared to their expenditures if they are about to use their private transport as overall daily travel mode which will be more costly and unpredictable. With respect to this matter, one of the viable approach is to provide more park and ride facilities at rail transit stations, which would benefit commuters with vehicle availability. In addition, the trip makers viewed the rail commuter system and its park-and-ride facilities as a better alternative than using private vehicles to travel from the suburbs to city centre (Hamid et al., 2007, Hamid et al., 2011]). In the long run, the use of park and ride facilities would lead to less congestion on the streets in the city centre because of the presence of fewer cars. In addition, it is believed that the use of park and ride facilities will be able to improve the modal split that favours more towards public transport as the ideal form of sustainable transport system in reducing urban congestion.

There was only one indicator located in quadrant QIII: Low Priority. The indicator was P4: Parking fee in the station. The indicator which was located in Quadrant QIII was rated as low importance and low performance which do not require any additional efforts to improve (Grujicic et al., 2014). Interestingly, frequent rail users who are using their private vehicles from home to rail station implied that there were two indicators which of great importance but have poor performance (lower satisfaction). The indicators were P5: Security concerns and safety issues (guarded parking space, etc.) and P6: Facilities toward disabled people which were located in Quadrant IV: Concentrate here. The frequent rail users who are using park and ride from home to station assessed these indicators as being highly importance to them, but of unsatisfactory performance. In other words, the indicators located in this quadrant should be emphasized and urgently improved because of the low user's satisfaction but has been identified as highest priority to frequent rail users who is taking bus from home to station. Results from the analysis specified that by emphasizing the indicators in quadrant, QIV: Concentrate here, may enhance the park and ride facilities and at the same time improving the rail transit service in KV from frequent rail transit users point of view.

Interestingly, frequent rail users who were using park and ride mode to reach rail station from home rated facilities performance for disabled peoples as slightly less than average. Currently, improvement on disabled facilities at rail station was on-going in order to make rail services accessible to all users. For instance, the RapidKL Company, which was the service operator for Light Rail Transit (LRT) in KV has provided more accessible facilities at the station. As example, they were providing ramps and accessible lift for wheelchair users, parking for disabled, accessible toilets etc. However, the respondents in this study were using different types of rail transit system and their evaluations were basically based on accessibility condition at rail station that provide poor accessible and disabled people's facilities.

The confidence interval of 95% was applied in this study to prevent a mistake in selecting and considering park and ride indicators that should be prioritized. The IPA integrated with confidence intervals showed the range in which the population indicators will be likely. The relationship between six park and ride indicators and confidence intervals with equal population variances assumption and unequal population variances assumption are shown in Figure 4.66 and 4.67. In addition, the summary of traditional IPA results (Figure 4.65) and IPA results under different population variances assumption with 95% confidence intervals is presented in Table 4.43.

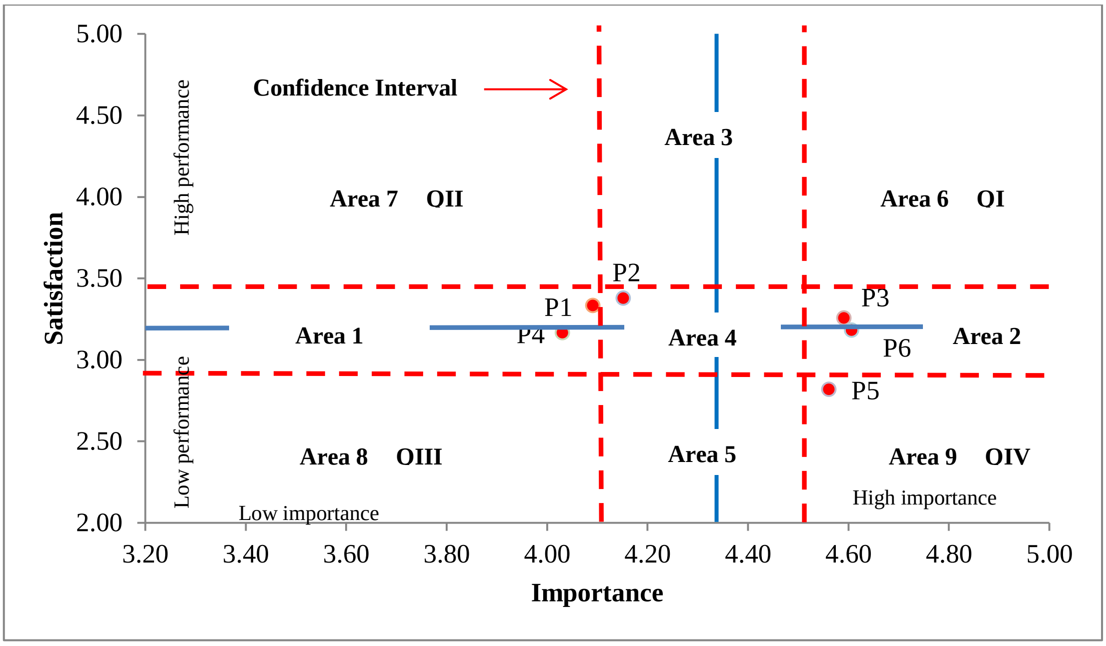

Figure 4.66: The IPA Plot for 95% Confidence Intervals with Equal Population Variances Assumption of Park and Ride Indicators

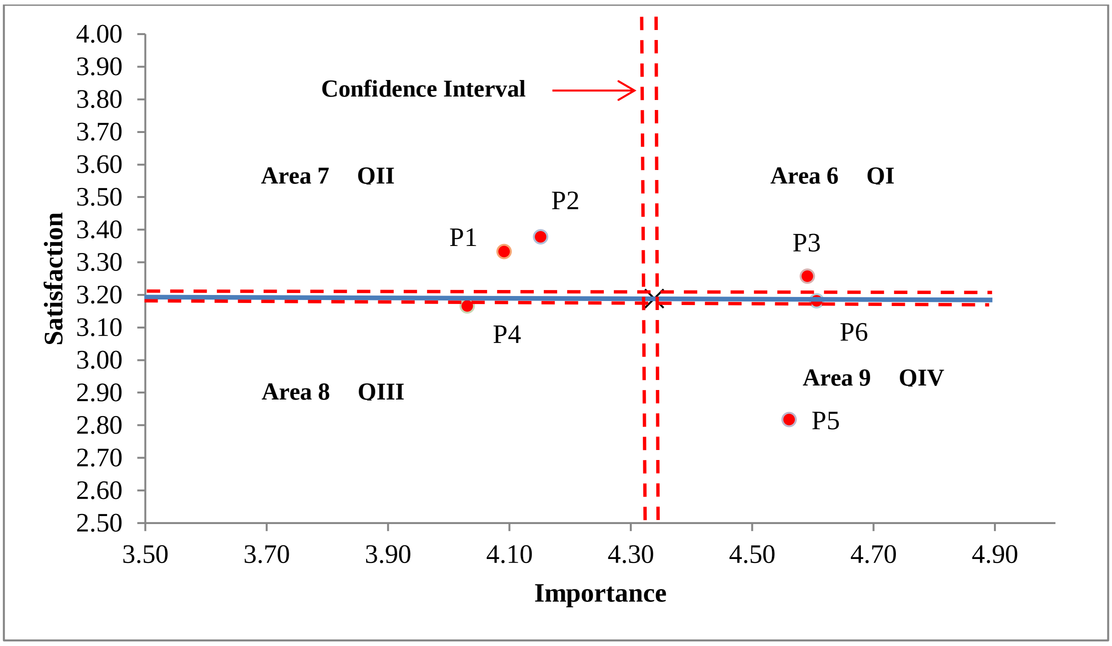

Figure 4.67: The IPA Plot for 95% Confidence Intervals with Unequal Population Variances Assumption of Park and Ride Indicators

Table 4.43: The Comparison and Summary of Park and Ride Indicators for Traditional IPA and IPA with 95% Confidence Intervals under Different Population Variances Assumptions

Park and Ride Accessibility Indicators	Traditional IPA	IPA with Equal Population Variances Assumption	IPA with Unequal Population Variances Assumption
P1.Total fuel consumption from home to station.	QII: Possible Overkill	Undetermined	QII: Possible Overkill
P2.Access time from home to station.	QII: Possible Overkill	Undetermined	QII: Possible Overkill
P3.Availability of parking space at rail station	QI: Keep up the good work	Undetermined	QI: Keep up the good work
P4.Parking fee in the station.	QIII: Low Priority	Undetermined	QIII: Low Priority
P5.Security concerns and safety issues (guarded parking space, etc.).	QIV: Concentrate here	QIV: Concentrate here	QIV: Concentrate here
P6.Facilities toward disabled peoples.	QIV: Concentrate here	Undetermined	Undetermined

The four quadrants IPA plot for 95% Confidence Intervals with Equal and Unequal Population Variances Assumption were divided into nine areas by four dotted lines (lower and upper confidence limits) as depicted in Figure 4.66 and Figure 4.67. The lower and upper confidence limits were calculated using Equation (9) until Equation (12), which was showed in Chapter 3. Based on Figure 4.66, the IPA Plot for 95% confidence intervals with equal population variances assumption showed that five indicators were located in confidence interval area or undetermined areas because of sampling variability. It was found that indicator P5: Security concerns and safety issues remained in quadrant QIV: Concentrate here regardless of the sample choice with a probability of 95%. Based on this analysis, improvement on security at park and ride facilities should be prioritized in order to improve frequent rail users' satisfaction level. In the long run, improvement on park and ride services is important to retain the existing rail transit users and attract new users to use rail transit system.

Interestingly, it was discovered that there were two park and ride indicators, which have the possibility to be located in the quadrant QIV: Concentrate Here for the IPA Plot of 95% Confidence Intervals with Equal Population Variances Assumption. The indicators were P2: Access time from home to station and P3: Availability of parking space at rail station. It was found that these two indicators were in the confidence interval area, which means that there is a probability that analysis on a new sample will not allocate these indicators in their existing IPA quadrants. It can also be seen that indicator P6: Facilities toward disabled peoples was in the confidence interval, which means that there is a possibility that analysis on a new sample will not assign this indicator in quadrant QIV.

On the contrary, the IPA Plot for 95% confidence intervals with unequal population variances assumption (Figure 4.67), showed different findings as compared to IPA Plot for 95% confidence intervals with equal population variances assumption (Figure 4.66). The IPA Plot for 95% confidence intervals with unequal population variances assumption depicted similar findings as Traditional IPA Plot (Figure 4.65) except for indicator P6: Facilities toward disabled peoples. This indicator was located in undetermined area, which means that there is a probability that a new sample analysis will not assign this indicator in Quadrant QIV.

4.9.5 Importance Performance Analysis for Drop-off Mode

In this study, drop-off mode referred to frequent rail users that are driven to a station by private transport and then access the transit station (kiss-and-ride). The kiss-and ride is a strategy that allows rail transit mode to increase daily ridership and market share without the expense of supplying any additional parking spaces. This is because, instead of having to park in the rail station, the commuters are driven to the station by another person, dropped-off and then was pickup on their return trip. However, it was found that the study on drop-off mode (kiss-and ride) is rarely investigated in the literature and no specific studies were addressed the benefits and potential of kiss-and ride access in rail ridership increment. The use of drop-off mode will reduce the possibility of household to have more than one vehicle for their journey, fewer automobiles on the road and will positively build a more transit-oriented population and less dependent on the automobile. Optimistically, the findings from this study will assist and contribute to the related research of kiss-and-ride access benefits in the literature in the future.

In this section, the Traditional Importance-Performance Analysis (IPA) and the IPA results under different population variances assumption with 95% confidence intervals for drop-off (kiss-and-ride) access mode was presented and discussed. For this mode, five indicators were investigated. The responses for this analysis were obtained from 17.3% of frequent rail users who were drop-off at rail station by their spouse, friend or families to travel with rail. The IPA Model was presented as a two-dimensional matrix in the coordinate system (x-axis importance, y-axis satisfaction), which forms four-quadrants, namely Quadrant I: Keep up the good work, Quadrant II: Possible Overkill, Quadrant III: Low Priority and Quadrant IV: Concentrate Here. After plotting all the drop-off indicators, it was proposed that a decision maker and service operator will then be able to determine the strengths and drawback of the existing drop-off or kiss-and-ride access facilities at the rail station. The reliabilities of satisfaction and importance for drop-off indicators were measured by Cronbach's alpha (α). It was found that the Cronbach's alpha (α) value for each measurement was similar, namely, 0.85. It was indicated that the drop-off indicators for satisfaction and importance showed high reliability (Hinton et al., 2004). The drop-off accessibility indicators for importance levels were rated on a five point

Likert scale ranging from 1- *not at all important* to 5-*extremely important*. Whereas, satisfaction (performance) levels were rated on a five point Likert scale ranging from 1- *not at all satisfied* to 5-*extremely satisfied*. The results for all six indicators (D1 to D5) in terms of the I-S Model for drop-off mode were presented in Table 4.44 and Figure 4.68. The quadrants or zones of which the park and ride accessibility indicators are fall into were also presented.

Table 4.44: The Importance and Satisfaction Relative Value of Drop-off Indicators

Drop-off Accessibility Indicators	**Importance**		**Satisfaction**		**Quadrants/ Zones**
	Average	**Std. Deviation**	**Average**	**Std. Deviation**	
D1. Drop-off area	4.38	0.791	3.50	1.013	QIII: Low priority
D2.Temporary waiting area	4.28	0.833	3.40	1.025	QIII: Low priority
D3.Access time from home to station.	4.38	0.813	3.91	0.864	QII: Possible overkill
D4.Safety during waiting and drop-off time.	4.67	0.632	3.66	0.928	QI: Keep up the good work
D5. Facilities toward people with disabilities.	4.38	0.644	3.64	0.931	QII: Possible overkill
Average	**4.42**	**0.743**	**3.62**	**0.952**	

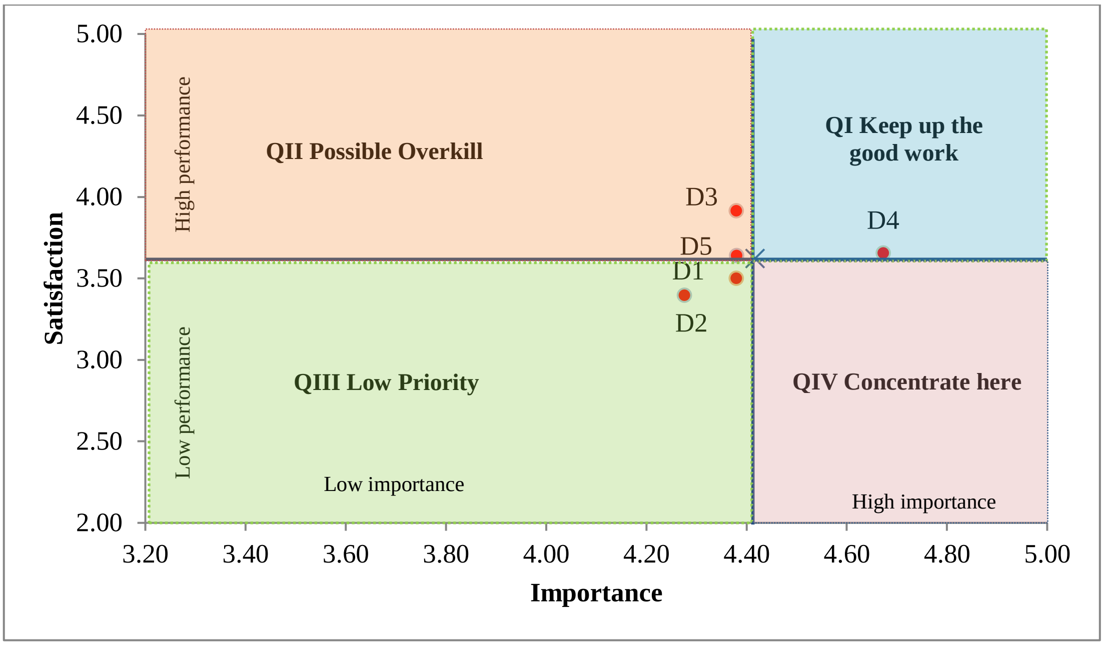

Figure 4.68: Drop-off Accessibility Indicators Distributed per Quadrants

As tabulated in Table 4.44, the average importance score for park and ride mode accessibility across all six indicators was 4.42 and average satisfaction score was 3.62. In Traditional IPA as shown in Figure 4.68, there were only one indicator, namely, D4.Safety during waiting and drop-off time was located in Quadrant QI: Keep up the good work, which referred as high importance and high level of satisfaction. This showed that frequent rail users were satisfied with current safety level at rail station when they were dropped-off at the rail station by their spouse or households. It was discovered that there were two indicators located in Quadrant QII: Possible Overkill, namely, D3: Access time from home to station and D5: Facilities toward people with disabilities. The indicators located in this quadrant achieved high satisfaction level but low importance level. However, interestingly, O'Neil and Palmer (2004) addressed the indicators located in Quadrant II as reflective of the fact that certain features or facilities of the rail transit access are not performing to their full service potential. Research carried out by O'Neil and Palmer (2004) suggested the organisation to take necessary efforts for indicators which were located in quadrant QII because of low importance weighting. Similar to park and ride access mode, it was indicated that access time from home to station was not the crucial indicator to frequent rail users who was dropped-off at the rail station as compared to other access modes. In this study, the frequent rail users who have been dropped-off to rail station is a member of the same household or the frequent rail users' spouse. This is because frequent rail users who have been dropped-off to rail station were carpooling with their spouse or household members by using private transport and they were flexible to plan their journey without waiting for public transport. In addition, it was indicated that disable facilities while they were being dropped off to station were fairly satisfied. However, further investigation on the disable facilities should be carried out by focusing the right group of respondents, namely, disable commuters and other related organization. Interesting research conducted by Sorenson (2003) discussed intensively the factors, which influence the commuters choice between park-and-ride and drop-off mode (kiss-and-drive). The factors which might influenced the commuters decision were automobile access time and distance, vehicle availability, parking capacity, parking fees etc. In addition, the commuters also considered the station location and number of transfers when they choose whether to utilize park and ride facilities or drop-off mode.

There were two indicators which located in quadrant QIII: Low Priority. The indicator was D1: Drop-off area and D2: Temporary waiting area. The indicators which located in Quadrant QIII were rated as low importance and low performance which do not require any additional efforts to improve (Grujicic et al., 2014). However, O'Neil and Palmer (2004) addressed Quadrant III as the area which required additional improvement from the organisation as the illustrated matrix apparently showed that drop-off mode is performing well below average. Interestingly, frequent rail users who have been dropped-out at the station perceived that there are no indicators located in Quadrant IV: Concentrate here. Although there was no indicator located in Quadrant IV, the confidence interval of 95% was also applied in drop-off mode to prevent a mistake in selecting and considering indicators that should be prioritized. The relationship between five indicators and confidence intervals with equal population variances assumption and unequal population variances assumption are shown in Figure 4.69 and 4.70. In addition, the summary of traditional IPA results (Figure 4.68) and IPA results under different population variances assumption with 95% confidence intervals is presented in Table 4.45.

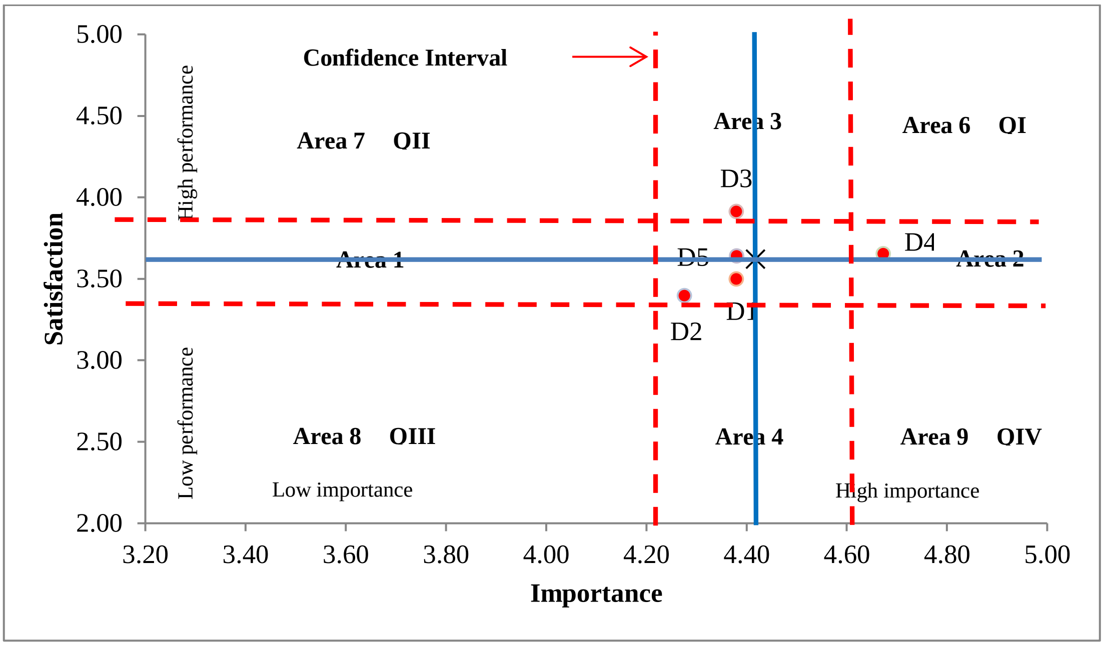

Figure 4.69: The IPA Plot for 95% Confidence Intervals with Equal Population Variances Assumption of Drop-off Indicators

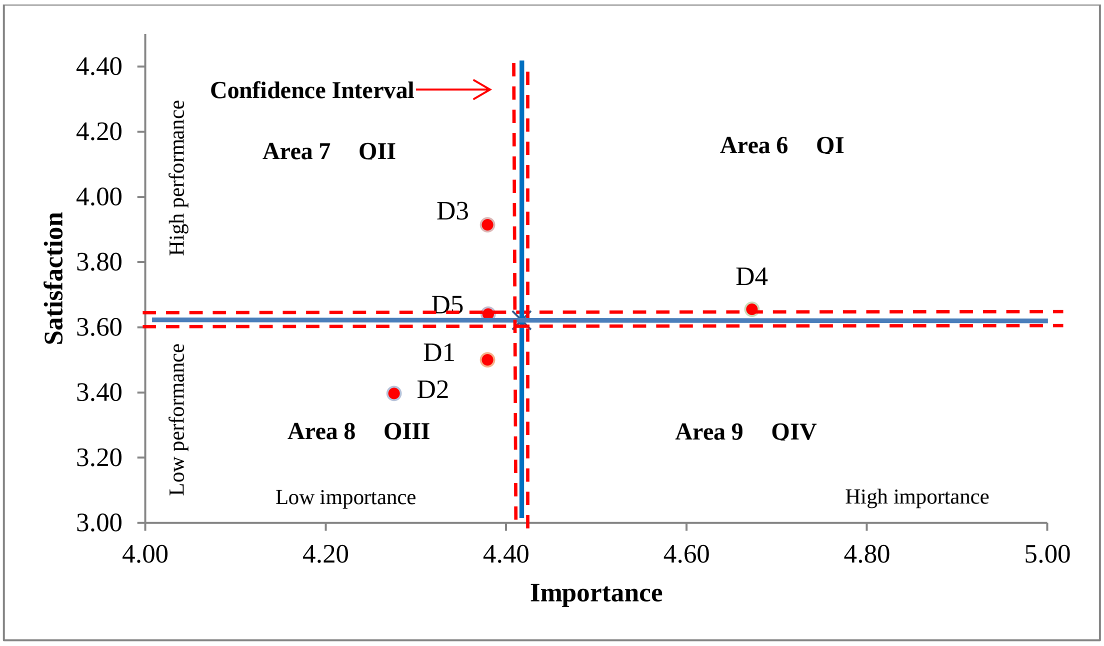

Figure 4.70: The IPA Plot for 95% Confidence Intervals with Unequal Population Variances Assumption of Park and Ride Indicators

Table 4.45: The Comparison and Summary of Park and Ride Indicators for Traditional IPA and IPA with 95% Confidence Intervals under Different Population Variances Assumptions

Drop-off Accessibility Indicators	**Traditional IPA**	**IPA with Equal Population Variances Assumption**	**IPA with Unequal Population Variances Assumption**
D1. Drop-off area	QIII: Low priority	Undetermined	QIII: Low priority
D2.Temporary waiting area.	QIII: Low priority	Undetermined	QIII: Low priority
D3. Access time from home to station.	QII: Possible overkill	Undetermined	QII: Possible overkill
D4. Safety during waiting and drop-off time.	QI: Keep up the good work	Undetermined	QI: Keep up the good work
D5. Facilities toward people with disabilities.	QII: Possible overkill	Undetermined	QII: Possible overkill

Similar to previous IPA Plot for different access mode, the four quadrants IPA plot for 95% Confidence Intervals with Equal and Unequal Population Variances Assumption of drop-off mode were depicted in Figure 4.69 and Figure 4.70. The lower and upper confidence limits were calculated using Equation (9) until Equation (12), which showed in Chapter 3. Based on Figure 4.69, the IPA Plot for 95% confidence intervals with equal population variances assumption showed that five indicators were located in confidence interval area or undetermined areas because of sampling variability. Interestingly, it was discovered and assumed that in the case of new samples, there were four indicators which have the possibility to be located in the quadrant QIV: Concentrate Here because there were in confidence interval area.These indicators were D1: Drop-off area, D2: Temporary waiting area, D4: Safety during waiting and drop-off time and D5: Facilities toward people with disabilities.

On the contrary, the IPA Plot for 95% confidence intervals with unequal population variances assumption (Figure 4.70), showed different findings as compared to IPA Plot for 95% confidence intervals with equal population variances assumption (Figure 4.69). The IPA Plot for 95% confidence intervals with unequal population variances assumption depicted similar findings as Traditional IPA Plot (Figure 4.68). Although there were no indicators located in Quadrant IV, proposed further investigation on dropped-off access mode behaviour and related facilities should be carried out. This was because of fewer sample size for dropped-off access mode commuters involved in this study. In addition, it was proposed that more relevant indicators should be added in the measurement because there was a possibility that important indicators were left out during questionnaire design and data collection.

The summary of all the access mode indicators for different IPA Plots which were located in quadrant QIV was tabulated in Table 4.46 below.

Table 4.46: Summary of Indicators Located in Quadrant QIV

IPA Plots	Access Mode Indicators
Traditional IPA	*W2.Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)*
	W9.Facilities toward people with disabilities
	W10.Security along the way to station
	T1. Access fare from home to station.
	T2. Access time from home to station.
	T8. Facilities toward people with disabilities.
	B2. Access time from home to station.
	P5.Security concerns and safety issues (guarded parking space, etc.).
	P6.Facilities toward disabled peoples.
IPA with Equal Population Variances Assumption	*W9.Facilities toward people with disabilities*
	P5.Security concerns and safety issues (guarded parking space, etc.).
IPA with Unequal Population Variances Assumption	*W2.Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)*
	W9.Facilities toward people with disabilities
	T2. Access time from home to station.
	T8. Facilities toward people with disabilities
	P5.Security concerns and safety issues (guarded parking space, etc.).

Based on Table 4.46, it can be seen that facilities toward disabled peoples are a crucial concern for the improvement of access mode efficiency that they used to reach rail station. Safety issues also became a concern especially to frequent rail users who access rail station by park and ride mode. This indicator appeared in each IPA Plots despite different variances assumption as tabulated in Table 4.47. This finding was in line with Land Public Transport Master Plan (Land Public Transport Commission, 2013b) which was to improve and add extra safety and security elements when designing new services to cater the needs of all public transport users. For walking mode, commuters perceived the walking comfort and disable facilities as the indicators that should be prioritized on if the authorities or service operators want to make frequent rail users travel with rail consistently. In this study, it was discovered that about 70.0% of frequent rail users who walked lived within 500 metres from station. It showed that walking to public transport services has a potential as the dominant access mode in the future if walking environment and facilities are greatly improved. It was believed that improvement on walking environment to reach public transport services will contribute to ridership increment (Wibowo, 2007). It was also proposed in Land Public Transport Master Plan that each of transit stop should be served by a walking catchment, namely 400 metres for outdoor pathway and over 400 metres for indoors pathway (Land Public Transport Commission, 2013a). Interestingly, commuters who accessed rail station by taxi, highlighted access time as indicator that should be improved on in Traditional IPA and IPA with Unequal Population Variances Assumption. This is because any increment on taxi access time will influence the whole journey time by rail transit.

It was also discovered that there were three access mode indicators, namely, T1: Access fare from home to station, B2: Access time from home to station and P6: Facilities toward disabled peoples were not considered as indicators that should be prioritized on when 95% confidence intervals with Equal and Unequal Population Variances Assumption was applied in Importance-Performance analysis. It was in line with the purpose of introducing the confidence interval which was to identify the indicators that would be located in the Quadrant QIV regardless of samples. Therefore, the philosophy of using confidence intervals in IPA was achieved by reducing the sampling variability and may assist the decision maker to make effective judgments under two different types of population variances assumptions (Wu & Shieh, 2009). It was indicated that by considering equal population variances assumption, most of the access mode indicators are undetermined when confidence intervals are introduced. On the contrary, unequal population variances assumption for different indicators is very common in practice (Wu & Shieh, 2009). Under such assumption, the decision maker was able to recognize the items located in different quadrants when different sample of size is used. Therefore, the proposed integration between confidence intervals and IPA with different population variances assumptions for different sample sizes is beneficial and practical when the decision maker faces different scenarios to apply IPA (Wu & Shieh, 2009).

4.10 Analysing the Structural Equation Modelling (SEM) to Evaluate Perceived Importance of Rail Transit System Traits

The proposed structural model for Perceived Importance of Rail Transit System Traits as depicted in Figure 3.7 was analyzed using Structural Equation Modelling (SEM). Each of the data in the latent construct was obtained from Part 4a: Rail Transit Users' Satisfaction, Part 4b: Perceived Service Quality of Rail Transit System and Part 4c: Perceived Importance of Rail Transit System in the questionnaire design. Before analyzing full structural model, the descriptive statistics of the data were discussed. The statistical information (mean, standard deviation and mode) of the rail users' travel experience, perceived service quality of rail transit system, rail users' satisfaction and perceived importance of rail transit system are tabulated in Table 4.47.

Table 4.47: Descriptive Statistics On Perceived Importance, Perceived Service Quality, Rail Users' Satisfaction and Rail Travel Experience

Latent Endogenous Variable	Mean	Mode	Std. dev.
Perceived Importance (PI)			
HI-1: Safety at station	4.5	5	0.75
HI-2: Service reliability	4.4	5	0.72
HI-3: Comfort & cleanliness	4.3	5	0.75
HI-4: Rail integration	4.3	5	0.84
HI-5: In-vehicle time	4.3	5	0.75
HI-6: Rail fare	4.4	5	0.71
HI-7: Access	4.4	5	0.78

Latent Endogenous Variable	Mean	Mode	Std. dev.
Perceived Service Quality (PSQ)			
HQ-1: Accessible	4.0	4	0.98
HQ-2: Comfortable	3.9	4	1.04
HQ-3: Secure	4.1	4	0.91
HQ-4: Reliable	4.0	4	0.91
HQ-5: Affordable	3.7	4	1.07
Rail Users' Satisfaction (RUS)			
HS-1: Facilities	3.6	4	0.92
HS-2: Security	3.7	4	0.93
HS-3: Comfort	3.7	4	0.88
HS-4: Complains Management	3.6	4	0.95
HS-5: Frequency	3.7	4	0.89
HS-6: Fare	3.8	4	0.90

Latent exogenous variable: Rail Travel Experience (RTE)

HE-1: Travel cost from home to final destination (including return trip)	Proportion (%)	HE-2: Travel time from home to final destination (including return trip)	Proportion (%)
RM0-RM1.90	3.0	11-20 minutes	1.2
RM2.00-RM3.90	18.5	21-30 minutes	5.4
RM4.00-RM5.90	23.0	31-40 minutes	3.0
RM6.00-RM7.90	21.2	41-50 minutes	7.5
RM8.00-RM9.90	12.8	51-60 minutes	8.4
RM10.00-RM11.90	8.4	61-70 minutes	8.7
RM12.00-RM13.90	4.8	71-80 minutes	11.6
RM14.00-RM15.90	3.6	81-90 minutes	10.7
RM16.00-RM17.90	3.9	91-100 minutes	9.0
RM18.00-RM19.90	0.9	> 100 minutes	34.6

HE-3: Travel distance from home to station (including return trip)	Proportion (%)
0-10 km	2.4
11-20 km	49.6
21-30 km	24.5
31-40 km	8.7
More than 40 km	14.9

Based on the findings, all of the rail transit system traits were considered to be of very highly important, which showed a mode value of 5 and a mean value varied from 4.3 until 4.5. It was also indicated that safety at rail station is the highest priority when travel with rail transit as compared to other traits. Three rail transit system traits was rated with similar mean value, that is, 4.3. The traits were comfort and cleanliness, rail integration and in-vehicle time. As for service quality dimensions, it was discovered that rail users' perceived that the current rail transit system as of higher quality, which showed a mode value of 4 and mean value varied from 3.7 until 4.1. In addition, rail users agreed that current rail system provided high level of quality in terms of security level (4.1) as compared to other indicators. On the contrary, the comfortability (3.9) and affordability (3.7) aspect of rail transit system was perceived at slightly lower service quality compared to other indicators.

With regard to rail users' satisfaction, it was slightly above average with the mean value of 3.7-3.8, respectively). It was also discovered that rail transit users' were slightly more satisfied with the rail fare as compared to other indicators. This finding indicated inconsistent relationship between service quality and customer satisfaction in terms of fare. Although rail users' perceived that the current rail fare was averagely affordable, it was interesting to find that they were only slightly satisfied with the rate as compared to other indicators. It was found that 39.7% of the respondents spent more than their average (RM7.00) travel cost. Approximately 52.5% of the respondents took more than their average (88.0 minutes) travel time to reach their final destination from home. A majority of the frequent rail users travelled 20 km a day for their journey. In this study, the travel time, travel cost, and travel distance of the frequent rail users were included as latent exogenous constructs in the proposed structural model to evaluate the perceived importance of the rail transit system.

4.10.1 Models' Results and Fitness

The proposed structural model and measurement models results were analysed on the first run to validate and evaluate the model fitness with the data at hand. The full proposed structural model after the first run was depicted in Figure 4.71.

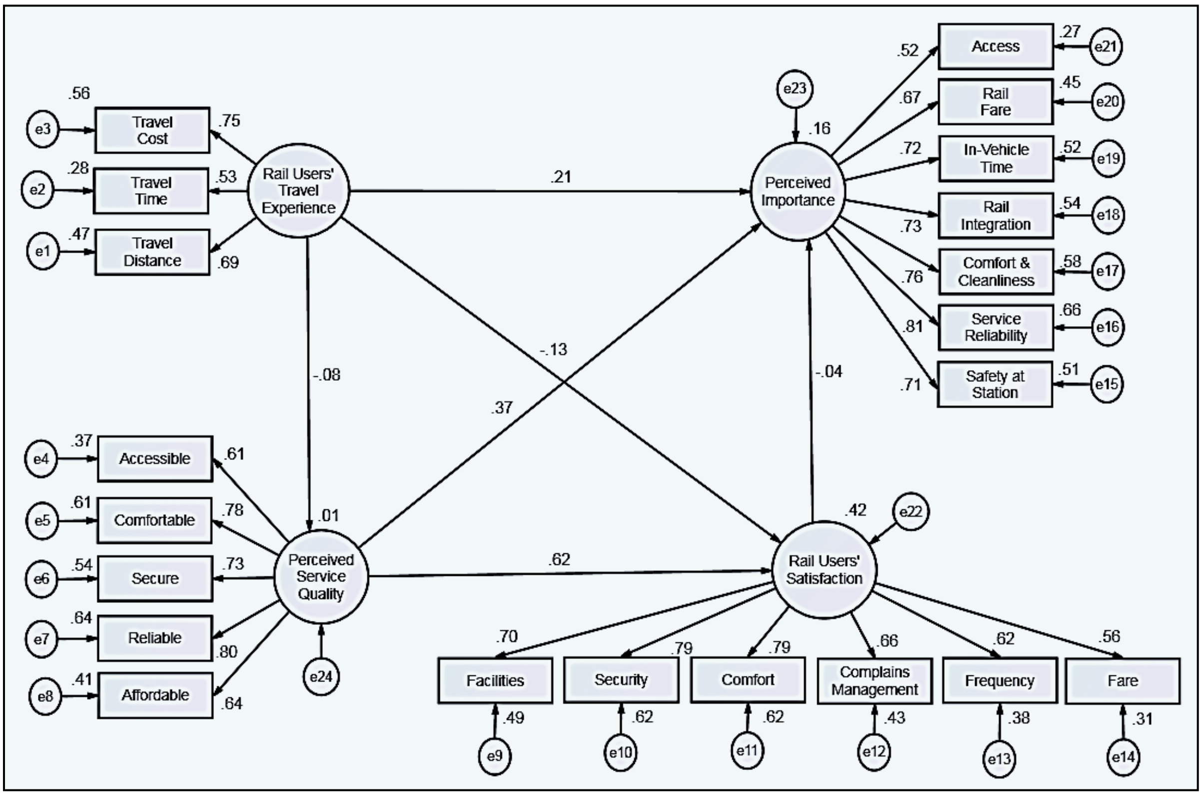

Figure 4.71: The First Run of Results for Proposed Structural Model to Evaluate the Perceived Importance of the Rail Transit System in Klang Valley

Figure 4.71 showed the standardized estimate of factor loading for each item in a measurement model in order to measure the workload of the construct. The factor loading for a particular item is shown near the arrow pointing to the respective item. While, the squared multiple correlations value or R^2 was located above each of the response item. As observed in Figure 4.39 and Table 4.23, the rail travel experiences construct have 3 response items and the perceived important construct have 7 response items. The rail service satisfaction construct have 6 response items and the perceived quality construct have 6 response items. The full model results before Confirmatory Factor Analysis (CFA) and Fitness Indexes Evaluation procedures are tabulated in Table 4.48. The first and second columns refer to the model variables. The third column showed the values of the regression weights of the coefficients (R.W.); the fourth and fifth columns showed the standard error and probability level of each coefficient. The last column showed the standardised regression weight (Std. R.W.).

Table 4.48: The First Run of Structural Model and Measurement Models Results

Latent endogenous variable	**Path**	***Latent exogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Perceived Service Quality	**<---**	**Rail Users' Travel Experience**	**-0.068**	**0.064**	**0.291**	**-0.075**
Rail Users' Satisfaction	<---	Perceived Service Quality	0.568	0.073	***	0.623
Rail Users' Satisfaction	<---	Rail Users' Travel Experience	-0.107	0.050	0.032	-0.131
Perceived Importance	<---	Rail Users' Travel Experience	0.166	0.057	0.004	0.206
Perceived Importance	<---	Perceived Service Quality	0.333	0.082	***	0.371
Perceived Importance	**<---**	**Rail Users' Satisfaction**	**-0.036**	**0.086**	**0.675**	**-0.037**
Observed exogenous variable	**Path**	***Latent exogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Travel Cost	<---	Rail Users' Travel Experience	1.950	0.267	***	0.745
Travel Time	<---	Rail Users' Travel Experience	1.820	0.256	***	0.530
Travel Distance	<---	Rail Users' Travel Experience	1.000			0.685

‘Table 4.48, continued’

Latent endogenous variable	**Path**	***Latent exogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Accessible	<---	Perceived Service Quality	0.866	0.093	***	0.609
Comfortable	<---	Perceived Service Quality	1.185	0.104	***	0.783
Secure	<---	Perceived Service Quality	0.973	0.090	***	0.734
Reliable	<---	Perceived Service Quality	1.060	0.092	***	0.801
Affordability	<---	Perceived Service Quality	1.000			0.644
Facilities	<---	Rail Users’ Satisfaction	1.030	0.097	***	0.699
Security	<---	Rail Users’ Satisfaction	1.164	0.099	***	0.788
Comfort	<---	Rail Users’ Satisfaction	1.108	0.095	***	0.789
Complaints Management	<---	Rail Users’ Satisfaction	1.000			0.657
Frequency	<---	Rail Users’ Satisfaction	0.880	0.092	***	0.617
Fare	<---	Rail Users’ Satisfaction	0.798	0.091	***	0.555
Observed endogenous variable	**Path**	***Latent exogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Safety at Station	<---	Perceived Importance	0.871	0.071	***	0.713
Service Reliability	<---	Perceived Importance	0.952	0.068	***	0.814
Comfort and Convenience	<---	Perceived Importance	0.933	0.071	***	0.765
Rail Integration	<---	Perceived Importance	1.000			0.734
In-vehicle Time		Perceived Importance	0.878	0.070	***	0.724
Rail Fare	<---	Perceived Importance	0.771	0.067	***	0.668
Access	<---	Perceived Importance	0.662	0.074	***	0.524

Table 4.48 presented the path (arrow) and its coefficients, which indicate how much the effects of every exogenous construct on the respective endogenous construct. The significance of every path coefficient was verified in the path analysis. Through analysis, it was discovered that four proposed causal effect for latent constructs indicated significant relationship at the 0.05 level (two-tailed). For instance, the path coefficient of Perceived Service Quality to Rail Users' Satisfaction was 0.62. This value indicated that for every one unit increased in Perceived Service Quality, its effects would contribute 0.62 unit increase in Rail Users' Satisfaction. Importantly, the effect of Perceived Service Quality on Rail Users' Satisfaction is significant ($p < 0.05$). Therefore, the hypothesis that Perceived Service Quality has significant and positive effect on Rail Users' Satisfaction was supported. On the contrary, it was discovered that two causal effect relationships were not significant ($p > 0.05$). The insignificant paths were the relationship of (1) Rail Users' Travel Experience on Perceived Service Quality and (2) Rail Users' Satisfaction on Perceived Importance of Rail Transit System. For instance, the path coefficient of Rail Users' Travel Experience to Perceived Service Quality was -0.08. This value indicated that for every one unit increased in Rail Users' Travel Experience, its effects would contribute 0.08 unit decrease in Perceived Service Quality. However, the effect of Rail Users' Travel Experience on Perceived Service Quality is not significant ($p > 0.05$). Therefore, the hypothesis that Rail Users' Travel Experience has significant and positive effect on Perceived Service Quality was not supported.

In order to liaise with study objective, the potential of mediation effects in the proposed structural model was investigated. There were three potential mediation effects considered. Those relationship were (1) Rail Users' Travel Experience- Perceived Service Quality-Rail Users' Satisfaction, (2) Rail Users' Travel Experience-Rail Users' Satisfaction-Perceived Importance and (3) Perceived Service Quality-Rail Users' Satisfaction- Perceived Importance. Based on the findings, it was discovered that the direct effect of Rail Users' Travel Experience on Rail Users' Satisfaction is significant at 0.05 level. However, when the potential mediator, namely Perceived Service Quality was entered into the model, it was found that the indirect effect of Perceived Service Quality on Rail Users' Satisfaction is not significant at the 0.05 level. Therefore, there were no mediation effect influenced in the proposed relationships.

In the first run, it was discovered that all the response items of each measurement model was found to be significant. Except for two causal paths, all other hypothesized relationships were statistically significant at the 0.05 level. It was discovered that the path coefficient for Rail Users' Travel Experience in the prediction of Perceived Service Quality is insignificant different from zero at the 0.05 level (two-tailed). In addition, the regression weight of Rail Users' Satisfaction in the prediction of Perceived Importance was also insignificant different from zero at the 0.05 level (two-tailed). In other words, the hypotheses, namely, H3 and H6 were not supported. Therefore, the proposed relationships (pointing arrows) of H3 and H6 were deleted. The proposed structural model was rerun. The proposed structural model and measurement models is validated using Confirmatory Factor Analysis (CFA) in order to reflect how fit is the model with the data at hand. In addition, the proposed structural model was then evaluated through several Fitness Indexes. The findings and discussions on CFA and model fitness evaluation will be presented in the following hereafter sections.

4.10.2 Confirmatory Factor Analysis and Model Fitness

In order to assess the validity of the measurement models, a Confirmatory Factor Analysis (CFA) was conducted. The CFA for all of the latent constructs were performed first before the interrelationship in a structural model were analysed. The Pooled CFA method for assessing the measurement model of latent constructs was applied due to its efficiency (Zainudin Awang, 2015). The CFA method has the ability to assess the Unidimensionality, Validity, and Reliability of a latent construct (Zainudin Awang, 2015). The unidimensionality assessment was made prior to the evaluation of Validity and Reliability. In unidimensionality assessment, any measuring item with a low factor loading was removed or deleted from the measurement model. In this study, the factor loading for every indicator or measuring items should exceed 0.50 in order to achieve unidimensionality. The response items with a factor loading greater than 0.50 were retained (Hair et al., 2010). The deletion was made one item at a time, by removing the lowest factor loading at first. The deletion process was continued until the unidimensionality requirement was achieved. In unidimensionality asessment, all factor loadings were required to be positive in one direction. After the unidimensionality asessment, the validity measurement was conducted. The involved validity measurement were convergent validity, construct validity and discriminant validity of the constructs in the model (Holems-Smith & Coote, 2006). The model reliability is assessed through the Internal Reliability test, Composite Reliability (CR) test, and Average Variance Extracted (AVE) test. Reliability refers to the extent to which a scale produces consistent results if repeated measurements are made using the same measurement tool (Barsky & Labagh, 1992; Hinton et al., 2004). The Cronbach's alpha is used to assess internal consistency. The Cronbach's alpha reliability coefficient for three measurement models was more than 0.8 (Perceived Service Quality = 0.822, Rail Users' Satisfaction = 0.841, and Perceived Importance = 0.873), which indicates that the reliability of the measurement is very high (Wheaton et al., 1977). Whereas the Cronbach's alpha reliability coefficient for rail travel experience is 0.624, which implies that the reliability of the measure is moderate (Wheaton et al., 1977). The Composite Reliability (CR) indicates the reliability and internal consistency of a latent construct Kline, 2005). The CR values of four measurement models have exceeded the critical requirement (equal or more than 0.60).

The CR values were, Perceived Service Quality = 0.84, Rail Users' Satisfaction = 0.84, Perceived Importance = 0.88 and Rail Users' Travel Experience = 0.70, which achieved composite reliability and internal consistency of latent constructs. The Average Variance Extracted (AVE) value for three measurement models were equal or more than 0.50 (Perceived Service Quality = 0.52, Rail Users' Satisfaction = 0.50, and Perceived Importance = 0.50), which indicates that the average percentage of variation explained by the measuring items for the latent constructs achieved satisfactory reliability. However, the AVE value for Rail Users' Travel Experience was at 0.43, which was less than 0.50. This is because of less measuring items in rail user's travel experience construct. Therefore, this circumstance will be treated as limitation in this study. In overall, the developed structural model achieved satisfactory reliability.

The analysis of hypothesized or full structural model as shown in Figure 4.72 exhibited the significant relationships after Confirmatory Factor Analysis (CFA) and Modification Indices (MI) procedures. After the CFA procedure, it was discovered that the fitness indices for several model fit measurement were still below the required level even though the factor loading for all response items were above 0.5. It was suspected that certain response items are redundant to each other in the measurement model. Therefore, the response items redundancy was examined through Modification Indices (MI) in order to substantially improve the results. However, this step should be taken with caution. The MI for two pair of correlated errors, which indicates redundant items existed in the proposed model, was tabulated in Table 4.49.

Table 4.49: The Modification Indices Value between Each Pair of Response Item in Rail Users' Satisfaction

Response item error	**Correlation**	**Response item error**	**M.I.**	**Par Change**
e13 (Frequency)	<-->	e14 (Fare)	32.643	0.178
e11 (Security)	<-->	e10 (Comfort)	17.389	0.088

The high values of MI which was more than 15 were highlighted because it indicated the correlated errors between the response items. The MI value of 32.643 (e13 <--> e14) and 17.389 (e11<--> e10) was considered as high because it is greater than 15.0. By referring to the Rail Users' Satisfaction measurement model, the redundant items are comfort and security (e11<--> e10) as well as frequency and fare (e13 <--> e14). The model fitness was affected by the redundancies between the response items (Awang, 2015). The modification on these response items was carried out by correlated measurement errors of redundant items as "free parameter" and the analysis was rerun.

The final results of proposed structural model was depicted in Figure 4.72. The important figure need to be highlighted from the standardized estimate are the factor loading for every measuring or response items, the value of squared multiple correlation or R^2 and the fitness indexes for the model.

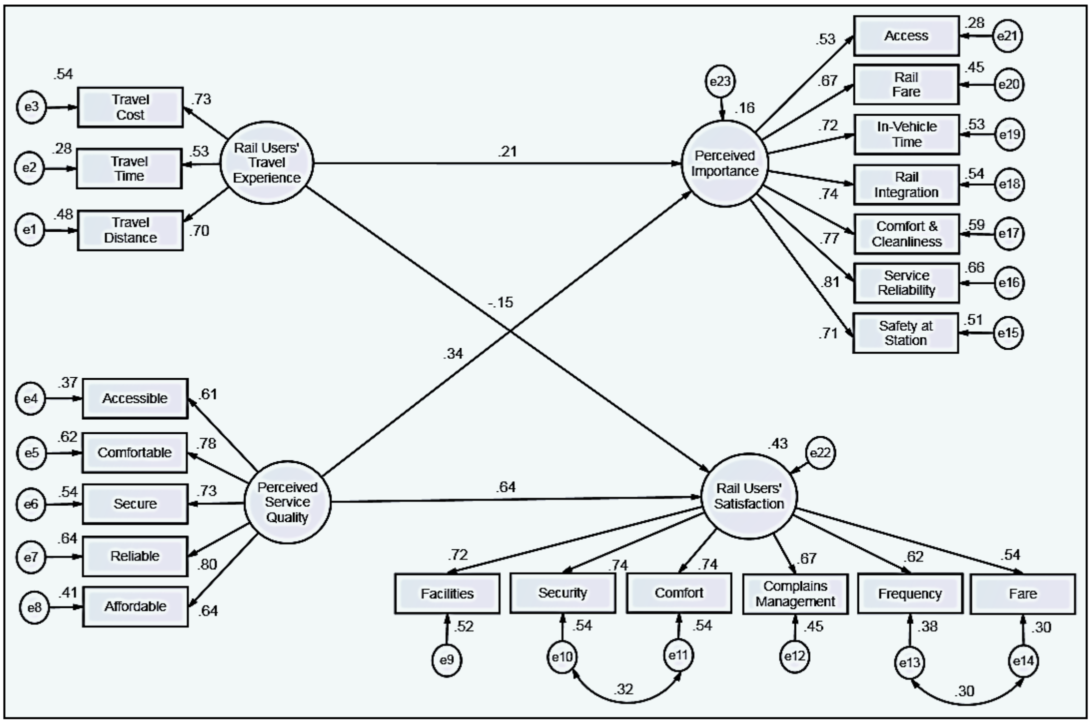

Figure 4.72: The structural model to evaluate the perceived importance of the rail transit system in Klang Valley

It was discovered that the standardised factor loading for each measurement model was significant and higher than 0.5 as presented in Figure 4.72 and Table 4.51. The proposed structural model explained 43% of variance in rail users' satisfaction and 16% of variance in perceived importance. The structural model is tenable in that the amount of variance explained in the variables displayed a practical significance. Except for two paths, all other hypothesised relationships were statistically significant ($p < 0.05$). The two statistically insignificant paths were the influence of rail users' travel experience on the perceived service quality (H3) and the influence of rail users' satisfaction on the perceived importance of the rail transit system (H6). Based on the finding, it was discovered that there was no mediator effect in the (1) rail users' travel experience-perceived service quality-rail users' satisfaction paradigm, (2) rail users' travel experience-perceived importance-rail users' satisfaction paradigm and (3) perceived service quality-rail users' satisfaction-perceived importance paradigm. The results of hypothesis testing indicated that there was no significant indirect effect relationship for each proposed paradigms. On the contrary, there was significant direct effect relationship between (1) perceived service quality and perceived importance, (2) rail users' travel experience and rail users' satisfaction, (3) rail users' travel experience and perceived importance, and (4) perceived service quality and rail users' satisfaction. The goodness-of-fit checking indices for the structural model are tabulated in Table 4.50.

Table 4.50: Fitness of the Hypothesised Structural Model for Perceived Importance of Rail Transit System

Name of indices*	Level of acceptance	Indices value in model
Absolute fit		
Discrepancy Chi Square, Chisq	p > 0.05 (Wheaton et al., 1977) (sensitive to sample size > 200)	p = 0.000
Root Mean Square Error of Approximation (RMSEA)	**RMSEA < 0.08 (Browne & Cudeck, 1993)**	**0.058**
Goodness-of-fit Index (GFI)	**GFI > 0.90 (Joreskog & Sorbom, 1984)**	**0.896**
Incremental fit		
Adjusted Goodness-of-fit Index (AGFI)	AGFI > 0.90 (Tanaka & Huba, 1985)	0.869
Comparative Fit Index (CFI)	**CFI > 0.90 (Bentler, 1990)**	**0.927**
Tucker-Lewis coefficient (TLI/NNFI)	**TLI > 0.90 (Bentler & Bonett, 1980)**	**0.916**
Normal Fit Index (NFI)	**NFI > 0.90 (Bollen,1989)**	**0.870**
Parsimonious fit		
Chisq/df	**Chisq/df < 5.0 (Marsh & Hocevar, 1985)**	**2.107**

As presented in Table 4.50, there were three model fit indices categories, namely, Absolute fit, Incremental fit and Parsimonious fit. The indices in bold are recommended goodness-of-fit checking indices since there are substantially reported in the literature (Hooper et al., 2008; Zainudin Awang, 2015). It was recommended by Hair et al. (1995), Hair et al. (2010) and Holmes-Smith (2006) to use at least three fit indices by including at least one index from each category of model fit. The absolute fit indices were measured and indicated of how well the proposed theory fits the data (Hooper et al. 2008). For absolute fit, it was found that the Chi-square value showed significant result at a 0.05 threshold. However, the absolute fit index of minimum discrepancy Chi-Square (Chisq) could be ignored since the sample size for this study is greater than 200 (Hair et al., 2010; Jöreskog & Sörbom, 1996). The Chi-Square (Chisq) statistic was greatly affected by sample size, which means that the Chi-Square statistic nearly always reject the model if large samples are used (Bentler & Bonnet, 1980; Jöreskog & Sörbom, 1993), while lack in power and may not able to differentiate between good or poor fitting models when small samples are used (Kenny & McCoach, 2003). The Root Mean Square Error of Approximation (RMSEA) fit statistic was regarded as one of the most informative fit indices in recent years due to its sensitivity to the number of estimated parameters in the model (Hooper et al., 2008; Mulaik et al., 1989). It was found that the RMSEA value was below 0.08, which showed a good fit (Joreskog & Sorbom, 1984). However, recently, a cut-off value close to 0.06 (Hu & Bentler, 1999) or a stringent upper limit of 0.07 (Steiger, 2007) was accepted as the general agreement in SEM analysis. In this analysis, the RMSEA value was 0.058, which indicated a reasonable approximate fit and below the recent cut-off value (Hu & Bentler, 1999; Kline, 2005; Steiger, 2007).

For incremental fit measurement, Comparative Fit Index (CFI) value was 0.927, which indicated a good fit (Bentler, 1990). The CFI index is one of the mostly reported fit indices because it was least affected by sample size (Fan et al., 1999). However, it was observed that the Goodness-of-fit-Index (GFI), Adjusted Goodness-of-fit Index (AGFI) and Normal Fit Index (NFI) were slightly less than the cut-off value. A major disadvantage to Normal Fit Index (NFI) is that it is sensitive to sample size and is an underestimating fit for samples which are less than 200 (Mulaik et al., 1989; Bentler, 1990; Kline, 2005; Hooper et al., 2008). In order to resolve this drawback, the Non-Normed Fit Index (NNFI) or Tucker-Lewis Index (TLI) was developed. This index was preferable because it is one of the fit indices less influenced by sample size (Tucker & Lewis, 1979; Bentler & Bonett, 1980). The TLI or NNFI value is 0.916, which indicates an appropriate model fit. For parsimonious fit, relative chi-square or normed chi-square (Chisq/df) was reported in order to minimize the sample size impact. Although there is no agreement among the researchers about the criterion for acceptance ratio on this statistic, it was recommended that the normed chi-square (Chisq/df) range from as high as 5.0 (Marsh & Hocevar, 1985; Schumacker & Lomax, 2004) to as low as 2.0 (Tabachnick & Fidell, 2007). For the proposed structural model, the normed chi-square (Chisq/df) value was 2.107, which indicated an acceptable fit. As a whole, it was observed that the structural full model has fulfilled all the criteria indicating that the model developed is statistically appropriate and fits the data well. The full model results were discussed in the following sub-section.

4.10.3 Models' results

Table 4.51 presented the path (arrow) and its coefficients, which indicate how much the effects of every exogenous construct on the respective endogenous construct. The significance of every path coefficient was verified in the path analysis. The first until third columns referred to the path and model variables. The fourth column showed the values of the regression weights of the coefficients (R.W.). The regression weights indicated the estimate of beta coefficient which measures the effects of every exogenous construct on the endogenous construct (Zainudin Awang, 2015). The fifth and six columns showed the standard error and probability level of each coefficient. The last column showed the standardised regression weight (Std. R.W.).

Table 4.51: The full structural model and measurement models results

Latent endogenous variable	**Path**	***Latent exogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Rail Users' Satisfaction	<---	Perceived Service Quality	0.590	0.076	***	0.636
Rail Users' Satisfaction	<---	Rail Users' Travel Experience	-0.125	0.052	0.016	-0.152
Perceived Importance	<---	Perceived Service Quality	0.307	0.060	***	0.341
Perceived Importance	<---	Rail Users' Travel Experience	0.167	0.055	0.002	0.209
Observed exogenous variable	**Path**	***Latent exogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Travel Cost	<---	Rail Users' Travel Experience	1.885	0.257	***	0.732
Travel Time	<---	Rail Users' Travel Experience	1.801	0.254	***	0.533
Travel Distance	<---	Rail Users' Travel Experience	1.000			0.696
Accessible	<---	Perceived Service Quality	0.866	0.093	***	0.609
Comfortable	<---	Perceived Service Quality	1.186	0.104	***	0.784
Secure	<---	Perceived Service Quality	0.973	0.090	***	0.734
Reliable	<---	Perceived Service Quality	1.061	0.092	***	0.801
Affordability	<---	Perceived Service Quality	1.000			0.643
Facilities	<---	Rail Users' Satisfaction	1.040	0.097	***	0.719
Security	<---	Rail Users' Satisfaction	1.066	0.100	***	0.735
Comfort	<---	Rail Users' Satisfaction	1.014	0.095	***	0.737
Complaints Management	<---	Rail Users' Satisfaction	1.000			0.670
Frequency	<---	Rail Users' Satisfaction	0.863	0.092	***	0.616
Fare	<---	Rail Users' Satisfaction	0.767	0.091	***	0.544

‘Table 4.51, continued’

Observed endogenous variable	***Path***	***Latent endogenous variable***	**Estimate**	**S.E.**	**P**	**Std. R.W.**
Safety at Station	<---	Perceived Importance	0.870	0.070	***	0.714
Service Reliability	<---	Perceived Importance	0.952	0.067	***	0.814
Comfort and Convenience	<---	Perceived Importance	0.933	0.070	***	0.766
Rail Integration	<---	Perceived Importance	1.000			0.735
In-vehicle Time	<---	Perceived Importance	0.878	0.070	***	0.725
Rail Fare	<---	Perceived Importance	0.771	0.067	***	0.669
Access	<---	Perceived Importance	0.662	0.073	***	0.526

Table 4.51 presented the results of Confirmatory Factor Analysis (CFA) and Modification Indices (MI) procedures. Based on the findings, rail users’ travel experience was found to have a positive effect ($\beta = 0.21$) on the perceived importance of rail transit system traits. This result indicated that if frequent rail users travel in a longer travel time, far trip distance, and spending higher travel cost, they are more likely to comprehend which rail transit traits are of higher importance to them based on their experience. In practical, frequent rail users tend to suggest which rail transit traits are more beneficial and are a priority to them in a way that will ease their journey to work. In addition, rail users’ travel experience was also found to have a negative effect ($\beta = -0.15$) on rail users’ satisfaction. This result implied that if frequent rail transit users travel in a longer trip distance, longer travel time, and spending higher travel cost, they tend to be dissatisfied with the rail transit system. The negative relationship also indicated that current frequent rail users are struggling in terms of their travel cost, travel time, and travel distance, despite its significance in contributing to travel satisfaction. Interestingly, frequent rail

users were more reflected towards unfavourable higher travel cost. It was revealed that 55.5% of frequent rail users spend more than RM6.00 and above for their journey, although a majority of them walk from home to the rail station. A possible explanation for this might be that frequent rail users have to change between rail stations because there is no direct route to their destination. From the literature, several studies discussed contradictory findings with respect to travel cost and travel time attributes. The studies carried out by Stradling (2002), Redman et al. (2013) and Chowdhury et al. (2015) pointed out that travel time is the most prominent trip attribute to travellers as compared to travel cost. However, Tillema et al. (2010) stated that travel cost plays an important role than travel time in residential location decisions of households in the Netherlands.

It was also discovered that perceived service quality has a positive effect (β = 0.64) on rail users' satisfaction. This finding indicated that if frequent rail users perceived the rail transit system to be of higher service quality, there is a higher tendency of frequent rail users to be highly satisfied with the system. This finding is consistent with the result of Parasuraman et al. (1988), Cronin and Taylor (1992), Tippichai et al. (2010), Park et al. (2006), and Eboli and Mazzulla (2011) studies, which agreed that service quality leads to passengers' satisfaction and is one of the key drivers of passengers' satisfaction. In addition, perceived service quality was also discovered to have a positive effect (β = 0.34) on the perceived importance of rail transit system traits. This result may be explained by the fact that if frequent rail users perceived that the rail transit systems provide higher service quality, there is a higher tendency of them to highly comprehend and identify which rail transit traits are significant for their journey.

For the perceived importance construct, it was found that there is no huge difference between the observed variables and indicators. However, by comparing indicator variables of perceived importance, service reliability is rated as the highest priority as compared to other rail transit system traits. Service reliability refers to the punctuality of service, which was measured in terms of time arrival and departure (Beirao & Cabral, 2007; Cantwell et al., 2009). The service reliability indicator explained about 16.4% of the total standardised regression weight, which was slightly higher than other perceived importance traits. This result is consistent with the result of Beirao and Cabral (2007) and Zhu et al. (2010) studies, which pointed out that reliability and travel time play a key role when choosing a mode of transport for work trips. However, this finding contradicted with the result of Fillone et al. (2005) study, which found that safety and security are more important than other traits. Improvements on service reliability by focusing on rail transit punctuality will reduce door-to-door journey times especially during peak periods. With regard to one of the study objectives, it was interesting to highlight that easy access was rated as the lowest priority as compared to other rail transit system traits. One of the identified factors with respect to quality attributes of public transport is accessibility to rail transit system (Biba et al., 2010; Wibowo & Chalermpong, 2010; Redman et al., 2012; Borjesson, 2012). Accessibility is defined as the degree to which public transport is reasonably available to as many people as possible (Lai & Chen, 2011). Several previous researches indicated that the satisfaction on access to railway station can be a determinant factor to increase ridership if rail is chosen as a travel mode alternative (Wardman & Tyler, 2000; Zhao et al., 2002; Krygsman et al., 2004; Givoni & Rietveld, 2007; Brons et al., 2009). In addition, research carried out by Wibowo and Chalermpong (2010) and Fillone et al. (2005) in Bangkok and Metro Manila found that those who live and have destinations within mass transit catchment areas are not the regular mass transit users. This was due to the lack of accessibility from the point of origin to the transit station. With relation to the case study area, namely, Klang Valley (KV), poor accessibility to rail-based public transport services was one of the issues focused in the Kuala Lumpur Structure Plan 2020 (Hall, 2004). It was identified that rail-based public transport services are far less accessible as compared to bus services and consequently, their ability to service patrons in a single trip from origin to destination is very limited. However, based on the finding, the rail users' in KV were prioritized more on service reliability and accessibility to rail transit system was considered the least priority in the proposed model. This was probably because all of the respondents have available vehicles for the journey, either of their own or their household vehicles. It was found that 37.0% of the respondents accessed rail station by using park & ride facilities and drop-off mode. In addition, 33.4% of the respondents walked to reach rail station from home. Houston et al., (2014) also found that households within 0.8km of a rail transit station are more likely to walk to the rail station and simultaneously contributed to higher rail transit trips. By cross checking access mode type and access distance, walking is found to be the dominant access mode within an access distance of 0 to 500 metres, with a share of 67.3%. Findings from these data indicated the possibility to promote walking as an effective access mode for access distance below 500 metres to rail station.

Interestingly, the final model had also highlighted the presence of inter-correlation effect between observed variables. In rail users' satisfaction construct, a positive correlation was found between comfort and rail safety satisfaction, r = 0.32. The frequent rail users are more comfortable travelling by rail as rail safety level increased. In addition, a positive correlation was also discovered between frequency and rail fare, r = 0.30. The frequent rail users are more satisfied about the rail fare if the rail frequency increased. From the structural model developed in the study, it is apparent that the perceived importance of the rail transit system cannot be evaluated independently from perceived service quality, rail users' travel experience, and rail users' satisfaction. It is observed that all factors hypothesised in this study contributed to the evaluation of rail transit system traits, which are of importance from frequent rail transit user's perception. The perceived service quality on the rail transit system is found to be the most significant factor influencing the priority level of rail transit system traits that are of importance to them (β = 0.34). This is instinctive because if frequent rail users perceived the rail services to be of higher quality, they will be able to understand rail transit system traits, which are of higher priority in fulfilling their expectation when travelling by rail. This will later improve the understanding of service operators and transport planners on travel behaviour among public transport users especially rail transit users. Simultaneously, perceived service quality is discovered as the most significant factor that influence rail users' satisfaction (β = 0.64). Several studies have shown that service quality was a significant driver of passengers' satisfaction and are directly related to passengers' behavioural intention on the product or system (Park et al., 2006; Ramayah & Ignatius, 2005; Chiou & Chen, 2012; Joewono et al., 2016). In addition, rail users' travel experience influenced rail users' satisfaction, but the relationship was negative ((β = - 0.15). Additionally, rail users' travel experience was also found to have significant influence (β = 0.21) on the perceived importance of the rail transit system traits in Klang Valley.

4.11 Chapter Summary

In this chapter, the result and analysis from all the data are presented and discussed. In the first part, the descriptive statistics analysis on socio-demographic data for both frequent rail users and private transport user was presented. In this study, the private transport users have experienced travelling by rail transit at least once in two months. The socio-demographic data involved were gender, access modes, age, vehicle availability, license availability, educational level, job status, ethnicity, travel purpose, monthly income, and number of trips per week. The overall daily trips data of frequent rail users and private transport users were also included. For frequent rail users, the data involved were travel origin and destination, access mode from home to station, access cost, access time, access distance, travel cost, travel time, travel distance and alternative travel mode.

Although private transport users travel with rail transit once in a while, the data on their access trips was also included in this study. In addition, the reasons of using rail transit system and private transport were presented and discussed. The current rail transit system performance and important levels of rail transit system traits was also discussed and highlighted.

In the second part, the results are presented in two sections. In the first section, the series of Binary Logit models for frequent rail users with respect to rail versus private transport under different hypothetical access and travel scenarios was presented. The utility of the two modes were compared in order to comprehend what will be a trade-off for frequent rail users if they shift to private transport. The probabilities of frequent rail users to (i) travel consistently by rail transit and (ii) shifting to private transport mode were examined. In overall, the frequent rail users were inclined towards private transport mode if their current access cost, access time, access distance, travel cost and travel time were about to increase. Contrary to expectation, the frequent rail users were less likely to shift to private transport mode by rail frequency decrement. The odds ratio tell us that as the rail frequency decreased by a unit, the change in the odds of shifting to private transport mode compared to rail transit is 0.268. The frequent rail users were 3.7 times more likely to use rail transit if rail frequency is about to increase. However, it was discovered that frequent rail users would completely shifted to private transport users if the current rail frequency decrease to 3 times per hour (20 minutes per interval). Therefore, the research hypothesis 1 until research hypothesis 6 was supported.

In the second section, the series of Binary Logit models is presented for private transport versus rail transit different hypothetical access and travel scenarios. The utilities of the two modes were compared in order to comprehend what will be a trade-off for private transport if they shift to rail transit. The probabilities of private transport users to

(i) travel consistently by rail transit and (ii) shifting to private transport mode under different hypothetical travel scenarios were examined. In overall, the private transport users were inclined towards rail transit mode if their current travel cost and travel time from home to final destination by private transport were about to increase. Simultaneously, the private transport users considered shifting to rail transit if access cost, access time, access distance was about to decrease. In addition, rail frequency increment showed significant role in increasing the probabilities of private transport users to shift to rail transit. Therefore, the research hypothesis 1 until research hypothesis 7 was supported. However, the shifting trend to rail transit was not clearly depicted as compared to shifting probability to private transport among frequent rail users. Based on both findings, the influence of inertia effect among frequent rail users and private transport users was highlighted. The effect of socio-demographic factors on shifting probability to rail transit or private transport were varied and influenced by different access and travel scenarios.

In the third part, evaluation on the current performance and important level of 37 access modes indicators was highlighted and discussed. The service quality for each access modes, namely, walking, taxi, bus, park and ride facilities and drop-off were analysed through Importance-Performance Analysis Integrated with Confidence Intervals method. This method is applied in order to find a way to improve the current access modes quality to rail transit system service from frequent rail users' point of view. The access mode indicators that showed higher importance levels and lower satisfaction levels were prioritized. Based on the findings, the IPA plot for 95% confidence intervals with different population variances assumption can be applied by the transport planners and service operators to determine and identify the indicators located in different quadrants when different sample size is used. Research by Wu and Shieh (2009) and Grujicic et al. (2014) proposed that the integration between confidence intervals and IPA with different population variances assumptions for different sample sizes is very useful and practical when IPA was applied in different scenarios.

Out of 37 access mode indicators, facilities toward disabled peoples became the crucial concern if access mode efficiency is to be improved. In addition, it was also discovered that safety issues became a major concerned especially to frequent rail users who accessing rail station by park and ride mode. Interestingly, for those who walk to reach rail station, walking comfort and disable facilities along the walkways became a major concern. Additionally, a potential of walking as the dominant access mode in the short distance was also discussed.

In the fourth part, the measurement models and the structural model to evaluate the perceived importance of rail transit system traits was presented. The influences of perceived service quality, rail users' travel experience, and rail users' satisfaction on the perceived importance of the rail transit system was analysed through Structural Equation Modelling (SEM) approach. Based on the findings and discussions, it was apparent that the perceived importance of the rail transit system cannot be evaluated independently from perceived service quality, rail users' travel experience, and rail users' satisfaction. The perceived service quality on the rail transit system was found as the most significant factor influencing the priority level of rail transit system traits that are of importance to them. In addition, perceived service quality was discovered as the most significant factor which influenced the rail users' satisfaction.

Finally, based on findings and relevant discussions, appropriate improvement and tenable policies which favour public transport service over private transport should be justified and implemented in order to provide sustainable transportation system and to make Klang Valley as liveable urban area.

CHAPTER 5: IMPROVEMENT ON WALKWAYS SURFACING TO ACCESS RAIL STATION

5.1 Introduction

It was discovered that walking comfort and convenience is one of the crucial accessibility indicators that should be prioritized to ensure that frequent rail transit users travelled consistently by rail. As discussed thoroughly in the findings, walking was discovered as a dominant access mode to reach rail station from home. Therefore, the selection of an appropriate walkways surface quality was focused as to improve the walking comfort and convenience to access rail station from home. In Malaysia, the choice of road surfacing is normally a conventional (flexible) pavement whilst the application of concrete (rigid) pavement for walkways is not widely used because of slow setting time during the construction process, poor riding quality, noise problems during usage and higher costs although they do have longer durability compared to flexible pavement. The conventional mixes used in flexible pavement tend to exhibit relatively poor resistance to rutting and cracking, which are the major problems in conventional flexible pavement.

The technology of semi-flexible pavement has been applied in the road maintenance and rehabilitation projects since 2001 in Malaysia. The current design of semi-flexible pavement surfacing uses imported cementitious material and polymer modified bitumen. Since the semi-flexible pavement is manufactured using the imported material, the production cost of semi-flexible pavement is highly dependent on the currency exchange. Thus, in order to avoid this fluctuation in cost, alternative local products are explored in this study to replace the imported cementitious material. Throughout this study, the potential of using the semi-flexible pavement surfacing as walkways was proposed due to its simple application, rapid readiness and its ability to alleviate severe deformation problems of conventional pavement materials. Thus, in order to overcome the weaknesses and improve the performance of walkways, an alternative semi-flexible pavement is considered.

5.2 Semi-flexible Pavement Surfacing Design

In this study, the semi-flexible pavement is suggested as an appropriate pedestrian walkways surfacing to access rail station from home. Semi-flexible pavement surfacing is a composite pavement that utilizes the porous pavement structure of the flexible bituminous pavement, which is grouted with an appropriate cementitious material. The objective is to improve the walking surface for pedestrian accessing the rail transit station in order to ensure the commuters travel consistently with rail. Therefore, the mechanical properties of cement-bitumen composites as an alternative semi-flexible pavement surfacing material is investigated and assessed in this study.

The objective of this study is to study the properties of the semi-flexible pavement surfacing, specifically the properties of impregnated cementitious grout in asphalt mixes. In the first stage, several types of grout mixture proportions containing different types of materials are used. In order to achieve good grout flowability and penetration, chemical admixtures have been added to the grout. The admixture used is a superplasticizer (SP). Several types of SP, with different chemical content and workability are used in the study. Appropriate compressive strength performance is achieved by varying water/cement ratio from 0.24 until 0.50 of the grout content. In addition, different pozzolanic materials are also applied to the grout mixtures in order to meet the strength requirement.

In the second stage, the open graded asphalt skeletons are designed and prepared. The asphalt mix is designed to attain relative percentage of voids between 25% to 30% to ease penetration of fresh grout mixture into the open graded asphalt skeleton. In the third stage, composite specimens are produced. The selected proportions of grout mixtures are used to fill up the voids in the open graded asphalt skeletons in order to manufacture the semi-flexible pavement. Several trial mixes are prepared and tested in order to determine the most appropriate binding method and at the same time to establish the acceptable design of the grout material to produce the most workable sample before further tests are conducted. An investigation on the properties of cementitious grout mixtures, open graded asphalt skeletons and the grouted pavement mixes are carried out by conducting compression strength test, flexural strength test, workability test, porosity test, resilient modulus test, air abrasion loss test and static load asphalt creep test.

In this study, the description ‘cementitious grout mixtures’ refers to a mixture of cementitious materials, water and admixture without aggregates. The description ‘open graded asphalt skeleton’ refers to a mixture of crushed aggregate (coarse and fine aggregates), bitumen and filler. Finally, the description ‘cement-bitumen composites’ refers to the open graded asphalt skeletons that have been filled up with different proportions of cementitious grout mixtures.

5.3 Preparation of Semi-flexible Pavement Surfacing

The preparation of semi-flexible pavement surfacing consisted of three stages. The first stage in developing semi-flexible pavement surfacing is to develop acceptable proportions of cementitious grouts. The second stage is to produce an open-graded asphalt skeleton and final stage is the production of the cement-bitumen composites. The appropriate and ideal proportions for these three type of samples, i.e. cementitious grouts, open-graded asphalt skeleton and cemen-bitumen composites are discussed in the following sub-sections. The preparation and testing of the samples are carried out in compliance with the Kuala Lumpur City Hall specification, Densiphalt Handbook, American Society of Testing and Materials (ASTM) Standard and the British Standard (BS). The preparation of the samples according to the Kuala Lumpur City Hall specification and Densiphalt Handbook are adapted to suit Malaysian conditions.

5.3.1 Cementitious Grout Design and Preparation

The contents and mix designs of the cementitious grout mixtures are important parameters, which are considered in this study. Two main criteria that are important to produce the cementitious grout mixtures are strength and workability. In order to fulfill these requirements, different cementitious grout mixes are proposed, produced and analyzed. The objective is to prepare flowable and high strength cementitious grouts that could infiltrate easily into pores of the open graded asphalt skeleton under the influence of gravitational action without a need for vibration. The cementitious grout mix design included the selection of different grout composition, variation of the water/cement ratios, type and the percentages of superplasticizer.

Three types of cementitious binders was used, i.e. Ordinary Portland Cement (OPC), White Cement (WC) and Silica Fume (SF). The specific gravity of OPC was 3.10 and the surface area was 335 m^2/kg. About 5% and 10% of silica fume (SF) was used as OPC replacement in order to produce sufficient strength grout. The specific gravity of SF was 2.2 and the surface area was 20 000 $m^{2/}$kg. A superplasticizer (SP) (polycarboxylic ether polymer chemical base) was used to enhance the workability or consistency of the cementitious slurries. It is widely known that better flowability is achieved by the addition of SP because SP allows better dispersion of the cement particles and therefore produces paste of higher consistency. The superplasticizer (SP) used was conformed to ASTM C494/C494M-13 Standard Specification for Chemical Admixtures for Concrete, Type F-Water-Reducing High Range Admixtures. The specific gravity of SP was 1.05 $\pm$ 0.02.

There were three main groups of cementitious grout mixtures that were designed, namely, CG1, CG2 and CG3. The first cementitious grout group (CG1) contains 100% OPC, the second cementitious grout group (CG2) contains 10% to 90% WC as a replacement to OPC and the third cementitious grout group (CG3) contains 5% and 10% of SF as replacement to OPC. The mix details of each group are tabulated in Table 5.1.

Table 5.1: The Design of Cementitious Grout Mixtures

Cementitious Grout Group	Cementitious binder content (%)			Water/binder ratio	Superplaticizer content (%)
	OPC	WC	SF		
CG1	100	0	0	The water/binder ratio for each cementitious binder design is 0.24, 0.26, 0.30, 0.32,0.34,0.36, and 0.40	0.5 1.0 1.5 2.0 2.5
CG2	90 80 70 60 50 40 30 20 10	10 20 30 40 50 60 70 80 90	0 0 0 0 0 0 0 0 0	The water/binder ratio for each cementitious binder design is 0.28, 0.30, 0.35 and 0.40	1.5 2.0 2.5
CG3	95 90	0 0	5 10	The water/binder ratio for each cementitious binder design is 0.30, 0.32,0.35, 0.40 and 0.50	1.0 1.5 2.0 2.5

Different water/binder ratios are used in order to attain the sufficient flow out time requirement while at the same time achieving the strength of the cement grout at 1 and 28 days. The water/ratio ratio used is between 0.24% until up to 0.50%. In this work, the percentages of SPs used are varied from 0.5% until up to 2.5% by weight of the grout content.

The cementitious grouts mixtures were produced using a mechanical mixer (8L) with varying speed in accordance to the ASTM C 305–99 Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency. The temperature of the work area during mixing is maintained between 20°C and 27.5°C (68°F and 81.5°F) and the relative humidity must not be less than 50%. At first, all the dry materials are mixed for about 1 min or more depending on the mixture proportions. 70% of the mixing water was then added to the mixture, followed by the SP. A balance of the mixing water is then added and then the mixture was mixed for 3 minutes at a higher speed. For fresh grout mixture, the (1) flow out time test and (2) density test is conducted. Meanwhile, the cube compressive strength test (50 x 50 x 50 mm) and flexural strength test (50 x 50 x 330 mm) is carried out on hardened concrete.

5.3.2 Open Graded Asphalt Skeleton

Open graded asphalt skeleton referred to the unfilled asphalt skeleton before it is impregnated with selected grout mixture proportions. Open-graded asphalt skeleton was composed of crushed aggregates (granite), 3.0% filler and 3.70% of 80/100 penetration grade bitumen. In this study, hydrated lime is used as filler instead of OPC. The purpose of the filler in the mix is to work as a void filling material as well as to stiffen the binder film on the aggregate particles. The open-graded asphalt skeleton was designed to achieve high void content of 25% to 30% while maintaining a thick binder coating on the aggregates. . The details on aggregate gradation for open graded asphalt mixture is shown in Table 5.2 and Figure 5.1. The aggregate gradation for open-graded design is provided by The Public Works Department, Kuala Lumpur City Hall, Malaysia

Table 5.2: Aggregate Gradation for Open Graded Asphalt Mixture – Type II

OPEN GRADED ASPHALT MIXTURE - TYPE II				Specification	
BS Sieve (mm)	**Weight retained (g)**	**Percent retain (%)**	**Percent passing (%)**	**Lower limit (%)**	**Upper limit (%)**
25	0.0	0	100	100	100
20	27.5	2.5	97.5	95	100
12.5	951.5	86.5	13.5	4	18
8	22.0	2	98	4	14
4.75	11.0	1	99	4	12
2	11.0	1	99	4	10
0.075	27.5	2.5	97.5	4	5
pan	49.5	4.5	95.5	0	0
Total	**1100.0**	**100**			

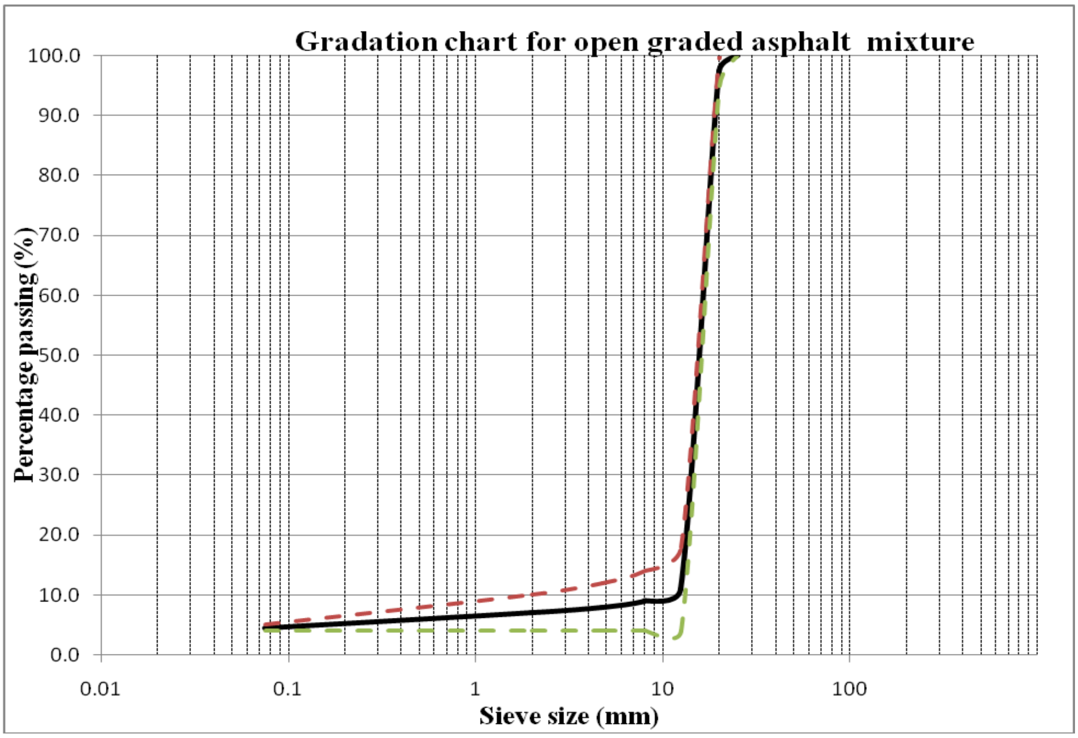

Figure 5.1: Gradation Chart for Open Graded Asphalt Skeleton

In open-graded design, high percentage of coarse aggregates was used and the amount of compaction was decreased. This is to achieve high air void content and to avoid unnecessary aggregate crushing. In hot and humid countries such as Malaysia, where the average monthly precipitation can be as high as 314 mm, (Wong et al. 2009) the use of open-graded pavement system can be extremely beneficial (Ibrahim et al. 2014).

At first, an open graded asphalt skeleton is weighed according to the weight of aggregates as shown in Table 5.2. The required quantity of the bitumen is heated in the oven at a temperature not more than 180ºC. The aggregates and the filler are heated in a pan until the temperature reached about 200ºC. The binder is poured into a pan when the aggregates temperature reached 200ºC. The aggregates and binder are mixed together until all the aggregates are uniformly coated with binder. Then, the sample is poured into the cylindrical moulds (100 mm diameter x 75 mm height) when temperature reached at 170ºC. The sample is allowed to cool until compaction temperature which is 155ºC. After that, the sample is compacted with a Marshall Compactor Machine. Each specimen is subjected to 50 blows per face corresponding to the normal compaction level. All the specimens are left to cool for 24 hours. The sample is remoulded after 24 hours and is cured at 25ºC and 75% relative humidity in a room before testing or impregnating later with cementitious grouts.

5.3.3 Cement-bitumen Composites

The cement-bitumen composites were produced by impregnating open-graded asphalt skeletons with selected proportions of cementitious grout mixtures. At first, the open-graded asphalt skeletons were weighed to determine the air voids content. After air voids test, the open-graded asphalt skeletons were fixed in the moulds that have been specially fabricated for grouting process. Then, the cement grout is poured onto the surface of the open-graded asphalt skeletons and spread using a rubber applicator. After the open-graded asphalt skeletons are completely filled, wet hessian and polythene plastic sheets were used to cover the freshly prepared cement-bitumen composites for 24 hours in a room at 25°C and 70% relative humidity until the testing day. The curing method for cement-bitumen composites is adapted from Hassan et al. (2002). The cement-bitumen composites were then tested at 1 day and 28 days.

5.3.4 Laboratory Testing

The properties of cementitious grout mixtures, open graded asphalt skeletons and cement-bitumen compistes are examined through various laboratory tests. The fresh cementitious grouts were tested for density and flow time to measure the workability of various cementitious grout compositions. In addition, it is to ensure that the grouts have the correct consistency to infiltrate easily into the open-graded asphalt skeletons. The test was carried out in accordance to ASTM C 939 1997 Test Method of Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method). Meanwhile, the hardened grout cubes were tested for compressive strength performance at the ages of 1, 3, 7 and 28 days. The compressive strength test was carried out in accordance to BS 1881: Part 116:1983 Testing Concrete. Method for Determination of Compressive Strength of Concrete Cubes.

The open-graded asphalt skeletons were tested for binder drainage, air void or porosity, compressive strength, indirect tensile stiffness modulus and air abrasion test. The binder drainage test was carried out in order to determine the binder content that an asphalt mixture holds without excessive binder drainage (Daines, 1992). The density, porosity and specific gravity of compacted open graded was tested in accordance to the ASTM D 2726-96a Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures. The indirect tensile stiffness modulus test was implemented in accordance to ASTM D4123-82 (Reapproved (1995) Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures.

The procedure of compressive strength test for open graded asphalt skeletons and cement-bitumen composites (semi-flexible pavement surfacing prototype) was referred to ASTM C-39-03 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. Instron testing machine with maximum 100 kN capacity was used to examine the compressive strength of cement-bitumen composites at 1 and 28 days. In addition, the measurement of open graded asphalt skeletons and cement-bitumen composites resistance to the particle loss was evaluated through Cantabro test. The Cantabro test on air cured samples was carried out in the Los Angeles Machine (ASTM C131-96 Standard Test method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact).

5.4 Results and Discussion

Based on the laboratory investigation, the properties of cementitious grout mixtures, open-graded asphalt skeletons and cement-bitumen composites are discussed in this section. The findings will give an overview on the suitability of cement-bitumen composites, i.e. semi-flexible pavement surfacing as the potential surfacing material for the walkways.

5.4.1 The Properties of Cementitious Grout Mixtures

The properties of cementitious grout mixtures are explained by the workability and compressive strength. The workability of cementitious grouts in the fresh state, was measured through flow time test. Meanwhile, the compressive strength is measured in the hardened state of cementitious grout mixtures. The workability and compressive strength of the cementitious grouts containing various proportions are presented in Table 5.3.

Table 5.3: The Workability and Compressive Strength of Different Cementitious Grout Mixtures

Cementitious grout design	Percentage of cementitious binder, %			w/c ratio	Percentage of superplasticizer (SP), %	Flow Time, (s)	Compressive strength, N/mm^2	
	OPC	WC	SF				1 day	28 days
CG1	100	0	0	0.30	1.5	23.4	57.6	85.5
	100	0	0	0.30	2.0	19.3	59.3	87.2
CG2a	95	5	0	0.30	1.5	17.2	48.2	76.4
	90	10	0	0.30	1.5	19.4	51.3	78.5
	80	20	0	0.30	1.5	21.0	57.9	93.8
	70	30	0	0.30	1.5	28.0	55.6	70.8
	60	40	0	0.30	1.5	32.0	53.1	68.4
	50	50	0	0.30	1.5	38.5	50.2	67.3
	40	60	0	0.30	1.5	44.2	48.5	66.7
	30	70	0	0.30	1.5	46.0	46.4	65.2
	20	80	0	0.30	1.5	47.0	43.6	64.8
	10	90	0	0.30	1.5	49.0	38.3	63.4
	0	100	0	0.30	1.5	54.0	32.4	62.5
CG2b	95	5	0	0.30	2.0	15.1	50.4	78.0
	90	10	0	0.30	2.0	16.2	52.4	80.3
	80	20	0	0.30	2.0	17.5	58.3	95.2
	70	30	0	0.30	2.0	23.3	56.1	72.3
	60	40	0	0.30	2.0	26.7	54.2	70.8
	50	50	0	0.30	2.0	32.1	53.4	68.3
	40	60	0	0.30	2.0	36.8	50.5	67.2
	30	70	0	0.30	2.0	38.3	47.1	66.1
	20	80	0	0.30	2.0	39.2	44.6	65.4
	10	90	0	0.30	2.0	40.8	40.3	64.3
	0	100	0	0.30	2.0	45.0	35.6	63.4
CG3a	95	0	5	0.30	1.5	18.0	55.4	91.7
	95	0	5	0.30	2.0	15.0	57.5	92.5
CG3b	90	0	10	0.30	1.5	22.5	57.5	90.2
	90	0	10	0.30	2.0	18.3	59.7	92.8

Based on Table 5.3, the workability and compressive strength performance of cementitious grout mixtures with different percentage of cementitious binders, 1.5-2.0% of superplasticizer (SP) and 0.30 water/cement (ratio) are presented. From the findings, it is found that the workability of cementitious grouts were influenced by various factors such as the water/cement ratio, dosage of SP and the use of supplementary cementitious materials.

The flow ability values for different cementitious grout designs were in the range of 54.0–15.0 s as tabulated in Table 5.3. The results show that the highest flow ability value was 54.0 s produced by cementitious grout mixture containing 100% WC, 0.30 w/c ratio and 1.5% SP. The lowest flow ability value was 15.0 s produced by cementitious grouts mixture containing 95% OPC, 5% SF, 0.30 w/c ratio and 2.0% SP. The increasing trend for workability (flow ability values decreasing) was showed at higher SP percentages. This showed that the dosage of SP significantly influences the workability or flowability, increasing the amount of SP produce higher workability of the cementitious grout, irrespective of w/c ratio (Koting et.al 2007). It was important for the grout mixtures to have appropriate consistency so that it can infiltrate smoothly in the cement-bitumen composites (semi-flexible pavement surfacing). It was also discovered that for all mixtures, the maximum dosage of SP, which is sufficient for workability requirement, was 2.0%. Through laboratory investigation and observation, at 2.5% SP dosage, samples (cementitious grout mixtures) tend to bleed. “Bleeding” or “water gain” is the tendency for water to rise to the surface of freshly placed concrete (Neville 1995). It results from the inability of the constituent materials to hold all the mixing water dispersed throughout the mix (Neville 1995).

According to Neville (1995), it is observed that the effectiveness of SP is improved by the existence of silica fume, SF. The use of SF affects significantly the properties of fresh concrete. The cementitious grout mixture with SF is strongly cohesive and, in consequence, there is very little bleeding or even none. The SP shows a greater effect in SF due to its very fine nature and greater surface area, which increase the water demand. The large surface area of the particles of silica fume, which have to be wetted, increases the water demand, so that, in mixes with a low w/c ratio, it is necessary to use a superplasticizer. This condition allows the use of high dosage of SP for very low w/c ratio without bleeding or segregation problems encountered with normal OPC concrete. In addition, flowable slurries without segregation and very high strength grouts are produce by using appropriate dosage of SP (Neville 1995).

The use of polycarboxylic ether polymer based SP was also highlighted in this study. The addition of a carboxylic based SP resulted in higher workability of the grout as compared to when a conventional SP (naphthalene formaldehyde sulphonate based SP) is used. This is because cement dispersion action can be greatly improved and thereby producing grouts with higher fluidity. The inclusion of a copolymer with a functional sulfonic group and carboxyl group maintains the electrostatic charge on the cement particles and prevents flocculation by adsorption on the surface of cement particles (Neville, 1995). The presence of the long lateral chains which linked to the polymer backbone generates a steric hindrance, which stabilises the cement particles capacity to separate and disperse (Sika Services AG, 2006). This characteristic provides flowable concrete with greatly reduced water demand (Sika Services AG, 2006). Instead of controlling the water-cement ratio, the cement dispersion will encourage the development of grout mixture with higher strength (Sika Services AG, 2006).

The workability performance of white cement (WC) replacement from 0-100% (CG2a and CG2b) in the cementitious grout mixtures was discussed in this study. It was discovered that the use of white cement (WC) in replacement of OPC shows significant influence on workability performance of the cementitious grout mixtures. The highest workability is 15.1s produced by 5.0% WC mixture and the lowest is 54.0s shows by 100% WC mixture. The use of WC from 10% to 100% shows significant effect because the flowability performance is slightly reduced. White cement is rapid hardening Portland (Type III) cement. This cement is use to develop the strength rapidly when formwork is to be removed early for re-use or where sufficient strength for further construction is required quickly (Neville, 1995). This is because due to a higher C_3S content (up to 70%)

and a higher fineness (minimum 325 m^2/kg) of the WC (Neville, 1995). Through observation during the laboratory work, the grout mixture containing WC hardened rapidly and it is found that the mixtures start hardening while it is still in the flow cone. This condition contributes to the lower flowability of the grout. In addition, the mixtures also hardened rapidly while transferred into the moulds. Due to these conditions, the workability performance of cementitious grout mixtures containing WC is lower as compared to OPC (CG1) and silica fume (CG3a and CG3b).

The compressive strength was determined at 1, 3, 7 and 28 days. From findings, the compressive strength of cementitious grouts are influenced by several factors such as water/cement ratio, type and amount of SP used, cement types and its content, different composition of grout mixtures and inclusion of supplementary cementitious material. From Table 5.3, the compressive strength performance varies between 32.4 N/mm^2 to 59.7 N/mm^2 at 1 day and 62.5 N/mm^2 to 95.2 N/mm^2 at 28 days. It was discovered that the compressive strength performance of cementitious grout containing SF was higher as compared to 100% OPC mixture with same SP percentages.

The highest compressive strength value at 1 and 28 days was produced by 20% WC, 80% OPC, 0.30 w/c ratio and 2.0% SP. However, the compressive strength value was lower for 30% WC replacement and above. This was due to incompatibility of WC and OPC for those percentages of mixture proportions. The effect of 5% SF replacement on compressive strength performance at 28 days is more significant as compared to 5% WC replacement with 2.0% SP. Silica fume contributes to the progress of hydration of the latter material (Davraz & Gunduz 2005). This contribution arises from the extreme fineness of the silica fume particles, which provide nucleation sites for calcium hydroxide. Thus, early strength development takes place (Davraz & Gunduz 2005). The contribution of silica fume to the early strength development (up to about 7 days) was probably through improvement in packing, that is, action as a filler and improvement of the interface zone with the aggregate (Neville 1995). In addition, the micro-filler effect from silica fume allows the silica to react rapidly and provide high early age strength and durability. The efficiency of silica fume was 3–5 times that of OPC and consequently vastly improved concrete performance.

In general, there is increment in compressive strength performance, which is parallel to increase in SP percentages for all cementitious grout mixtures. Increasing dosage of SP accompanied by a corresponding reduction of w/c ratio does appear to significantly affect the compressive strength performance (Neville 1995). The use of polycarboxylic based SP do not alter fundamentally the structure of hydrated cement paste, but the main effect is being a better distribution of cement particles and consequently, better hydration (Mohammed & Fang, 2011). This condition would explain why, in some cases, the use of SPs increase the strength of concrete at a constant w/c ratio. In addition, the use of polycarboxylic ether polymer also affects compressive strength performance especially at 28 days. It was stated in Hommer & Wutz (2005), Li et al. (2004) and Skripkiūnas et al. 2012), that carboxylic based SP not only disperse the material and actively influence cement hydration process but also improve the structure of cementations materials due to nano dispersion particles which present in their composition. The effect of the long molecules in the SP is to wrap themselves around cement particles and provide negative charge so that they can repel each other (Neville 1995). This will result in deflocculation and releasing of trapped water from cement flocks (Neville 1995).

A paired *t*-test is carried out in order to determine whether there is a significant difference between the two means of (1) workability value and (2) compressive strength value for different cementitious grout mixtures design. The paired sample *t*-test on the workability performance between 100% OPC mixture and 95% OPC, 5% SF, 0.30 w/c ratio with different SP content was carried out. Through paired sample *t*-test, it was discovered that 5% SF replacement in the cementitious grout mixtures influenced the workability performance at 1.5%. However, replacing cementitious grout with 5% SF and 2.0% of SP did not influence workability performance. This test yielded a *t* value of 4.347 for 1.5% SP that was significant ($p < 0.05$) and yielded a *t* value of 3.263 for 2.0% SP which was not significant ($p > 0.05$). From analysis, it is safely to conclude that there is no significant difference on workability performance by using 5% replacement of SF with different SP content.

The paired sample *t*-test was carried out on the compressive strength performance at 1 and 28 days between 100% OPC mixture and 95% OPC, 5% SF, 0.30 w/c ratio with different SP content. Replacing the cementitious grout mixtures with 5% SF influenced compressive performance at 1 and 28 days only for 2.0% of SP. This test yielded a *t* value of –15.254 at 1 day and 6.250 at 28 days for 2.0% SP which was significant at the 0.05 level ($p = 0.004$ (1 day) and $p = 0.025$ (28 days)). Based on the statistical analysis, there is significant difference on compressive strength performance at 1 and 28 days by using 5% replacement of SF for 2.0% of SP.

5.4.2 The Properties of Open Graded Asphalt Skeletons

It is important to investigate the characteristics of skeleton in order to observe the effects of cementitious grouts after impregnation with asphalt mixture. The measurement on the properties of open graded asphalt skeleton included the bulk density, specific gravity, voids in mixture, voids in mineral aggregate, voids filled with bitumen, compressive stregtn, resilient modulus and abrasion loss. The values of each measurement is presented in Table 5.4.

Table 5.4: The Properties of Open Graded Asphalt Skeletons

Measured properties	Values
Bulk density, *d* (g/cm^3)	1.81
Specific gravity, G_{mb} (g/ml)	2.52
Voids in total mix, *(VIM)* (%)	27.4
Voids in mineral aggregate, (*VMA*) (%)	33.9
Voids filled with bitumen, (*VFB*) (%)	19.2
Compressive strength, *fc* (N/mm^2)	1.39
Resilient modulus, *E* (N/mm^2)	2380
Abrasion loss (*AL*), (%)	14.9

Based on Table 5.4, the average void in total mix (*VIM*) which refers to the porosity of the mix was 27.4%. According to Densiphalt Handbook (2000), if the porosity or air voids is less than 25%, it will be difficult for selected cementitious grouts to completely fill the bituminous skeletons. Meanwhile, if the porosity or air voids is higher than 30%, the open-graded asphalt skeletons surface will not have the necessary flexibility, which means cracks will occur in the finished semi-flexible pavement surfacing. The compressive strength, *fc*, of the open-graded skeleton was 1.39 N/mm^2 after 1 day of curing. The open graded asphalt skeleton strength was slightly lower as compared to porous asphalt skeleton (1.69 N/mm^2) by Hassan et al. (2002).

However, the average stiffness modulus value of the open-graded asphalt skeleton exhibited higher elastic modulus of 2380 N/mm^2 as compared to the value of 1530 N/mm^2 porous asphalt skeleton produced by Hassan et al. (2002). It was also discovered that the resistance of the open-graded asphalt skeleton to particle loss as examined by the Cantabro test was 14.9% which was less than the abrasion loss required by Kuala Lumpur City Hall (2003), i.e., is a maximum of 15% from the initial mass of the specimen.

5.4.3 The Properties of Cement-Bitumen Composites

The grouted pavement mixes or cement-bitumen composites are produced by pouring selected grout slurries onto the surface of open graded asphalt skeletons which subsequently filled the voids under the influence of gravitational action. Adequate and constant supply of cementitious grout is provided to ensure that the bituminous matrix can be completely filled. The grouted pavement mixes are tested for physical, strength and deformation performances. Physical characteristics tests refer to bulk density and porosity of cement-bitumen composites. Compressive strength of cement-bitumen composites are measured to examine the influence of cement slurries on the performance of open graded asphalt skeletons. Deformation of cement-bitumen composites are investigated through indirect tensile stiffness modulus test and static load asphalt creep test. In addition, resistance of the cement-bitumen composites to the particle loss is measured through air abrasion test.

(i) Air void analysis of cement-bitumen composites

Air void analysis is carried out to determine the porosity of cement-bitumen composites. Air void analysis is calculated by subtracting the sum of the volumes of the butimen mixture volume and dry grout volume from the bulk volume of the grouted sample. After the trial and error, six different proportions of cementitious grouts are selected. The cementitious grout mixtures in Table 5.5 are selected because they showed sufficient workability and compressive strength performance at 1 and 28 days. Each cementitious grout mixtures are infiltrated into open graded asphalt skeletons to produce cement-bitumen composites (semi-flexible pavement surfacing prototype). The air void results for cement-bitumen composites with six different cementitious grout mixtures are presented in Table 5.5.

Table 5.5 : Air Void Results of Cement-Bitumen Composites

Cementitious Materials Proportions (%)	SP percentages, %	w/c ratio	Air void of Cement-Bitumen Composites, %
1. 100% OPC	2.0	0.30	5.8
2. 95% OPC + 5% SF	2.0	0.30	3.0
3. 90% OPC + 10% SF	2.0	0.30	4.2
4. 95% OPC + 5% WC	2.0	0.30	3.9
5. 90% OPC + 10% WC	2.0	0.30	4.1
6. 80% OPC + 20% WC	2.0	0.30	5.2

The cement-bitumen composite containing 95% OPC, 5% SF, 2.0% SP and 0.30 w/c ratio shows the lowest air void value, which is 3.0%. The cement-bitumen-composite containing 100% OPC, 2.0% SP and 0.30 w/c ratio shows the highest air void value, which is 5.8%. The schematic drawing of particles interaction with air voids between binder, aggregate and cement grout is presented in Figure 5.2. The aggregate was initially coated with asphalt cement binder. The binder acts as an adhesive agent that binds aggregate particles into a cohesive, interconnected mass. When bound by asphalt cement binder, aggregate acts as a stone framework, which provides strength and toughness to the structure of cement-bitumen composite. The cement grout was then poured gradually on the open graded asphalt surface. The slurry will then infiltrate into air voids under influence of gravitational flow. From Figure 5.2, it is seen that air voids were partially filled with cement grout.

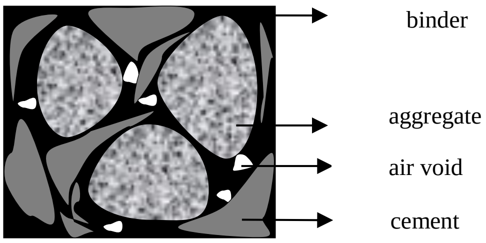

Figure 5.2: Particles interaction of cement-bitumen composite

It was discovered that the air void value was lower for cement-bitumen composite containing SF as compared to cement-bitumen composite containing 100% OPC. It is because of higher workability performance of cementitious grout mixture for the particular proportion. The higher percentage of SP produced lower air void value. This result is expected as the presence of higher percentage of SP fills the voids between the aggregates, thus reducing the air voids in the mix. This is an agreement with the workability performance of cementitious grout mixture using the same proportion. Therefore, the fluidity of cement grout is important criterion to ensure the air voids is completely filled in order to provide a solid, homogeneous grouted cement-bitumen composite structure. The effect of SF and WC replacement was seen from air voids result. Both replacements are found to refine the pore structure of the cement-bitumen composites and hence improve the performance properties.

In addition,the porosity (air void) of cement-bitumen composite is improving when replacing 5% SF in the mixture. This is probably due to compatibility of SF with SP content in the mixture. However, the porosity value increases when replacing the mixture with 10% SF. It is apparently because the presence of higher SF content contributes to the stickiness and denseness of the grout. Thus resulting less fluidity of grout to penetrate into the sample. The *t*-test analysis is carried out in order to determine whether there is a significant different between the two means of porosity (air void) value by replacing 5% and 10% of SF in the grout mixtures. Based on *t*-test analysis, it is found that replacement of 5% and 10% silica fume in the grout mixtures did not influenced the porosity performance. The *t*-test analysis yielded a t_{stat} value of 9.67 (t_{stat} = 9.67< $t_{critical}$ = 12.71, Accept H_0) for 5% replacement of silica fume which was not significant even at the 0.05 level (p = 0.0622). It can be safely concluded that replacement of 5% and 10% of SF in the grout mixtures was not significantly influenced the porosity performance of cement-bitumen composites.

(ii) Compressive strength of cement-bitumen composites

The cement-bitumen composites (semi-flexible pavement surfacing prototypes) were prepared and tested at 1 and 28 days. The compressive strength performance for different cement-bitumen composite designs at 1 and 28 days for 0.30 w/c ratio and 2.0% SP is presented in Figure 5.3.

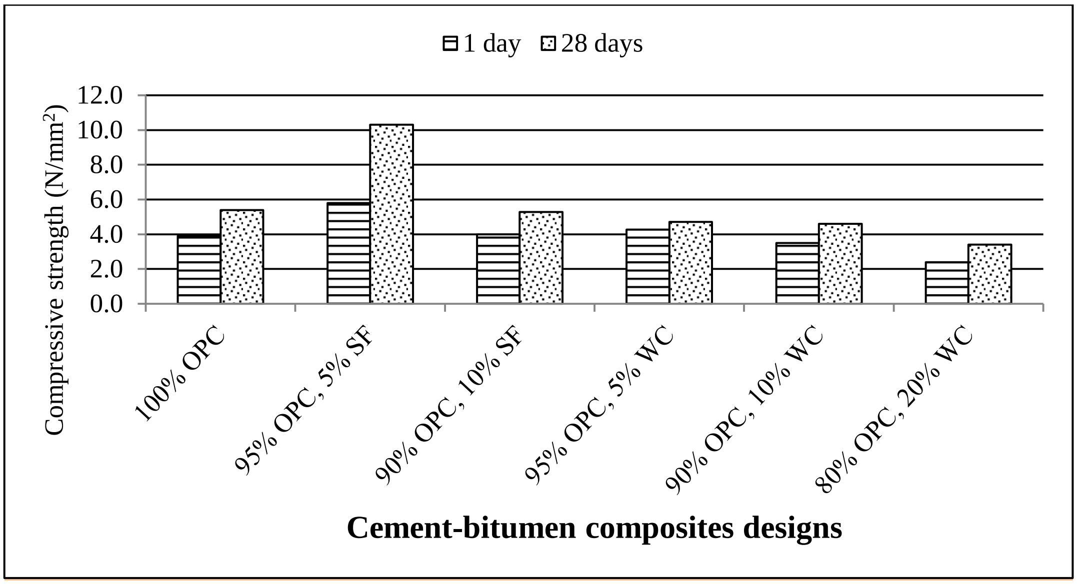

Figure 5.3: Compressive Strength Performance for Cement-Bitumen Composites

Based on the results, it was discovered that different cementitious grout designs are a major factor in influencing the strength of cement-bitumen composites. The study showed that the highest compressive strength of cement-bitumen composites was 5.3 N/mm^2 at 1 day and 10.3 N/mm^2 at 28 days. This result was produced by 95% OPC, 5% SF replacement. This is not in agreement with compressive strength value of cementitious grout mixtures as shown in Table 5.3. As a comparison, the cementitious grout mixture containing 80% OPC, 20% WC showed the highest compressive strength value (Table 5.3) as compared to other proportions. However, the cement-bitumen composites for this proportion (80% OPC, 20% WC) produced the lowest value in compressive strength performance at 1 day (2.4 N/mm^2) and 28 days (3.4 N/mm^2) as compared to other designs. For the cement-bitumen composites containing WC, it is difficult for the grout mixture to infiltrate into unfilled skeleton surface because the grout was dense and sticky. This condition leads to high porosity values of cement-bitumen composites containing WC, which influenced the compressive strength performance. As such, the use of WC in development of cement-bitumen composites for semi-flexible pavement surfacing does not have significantly increased in compressive strength at 28 days. The beneficial effect of 5% SF as a replacement material is significantly shown at 28 days. Silica fume particles enhanced particle packing and ultimately higher compressive strengths and enhanced durability was achieved because of the extremely small shape of the material.

For further verification, statistical analysis was performed on the influence of replacing 5% SF on the compressive strength performance at 1 and 28 days. The *t*-test analysis at 1 day between 100% OPC, 2.0% SP, 0.30 w/c ratio and 95% OPC, 5% SF with 2.0% SP, 0.30 w/c ratio yielded a t value of 13.67 which was significant at the 0.05 level ($p = 0.0465$). At 28 days, this test yielded a t value of 18.14 which was significant at the 0.05 level ($p = 0.0351$). Thus, replacing 5% silica fume in grout mixtures significantly influenced the compressive strength performance of cement-bitumen composites at 1 and 28 days.

(iii) Indirect tensile stiffness modulus of cement-bitumen composites

The indirect tensile stiffness modulus test on the cement-bitumen composites were carried out after 28 days of curing at 20 °C. The results of resilient modulus for different designs of cement-bitumen composites with 0.30 w/c ratio and 2.0% SP is presented in Figure 5.4.

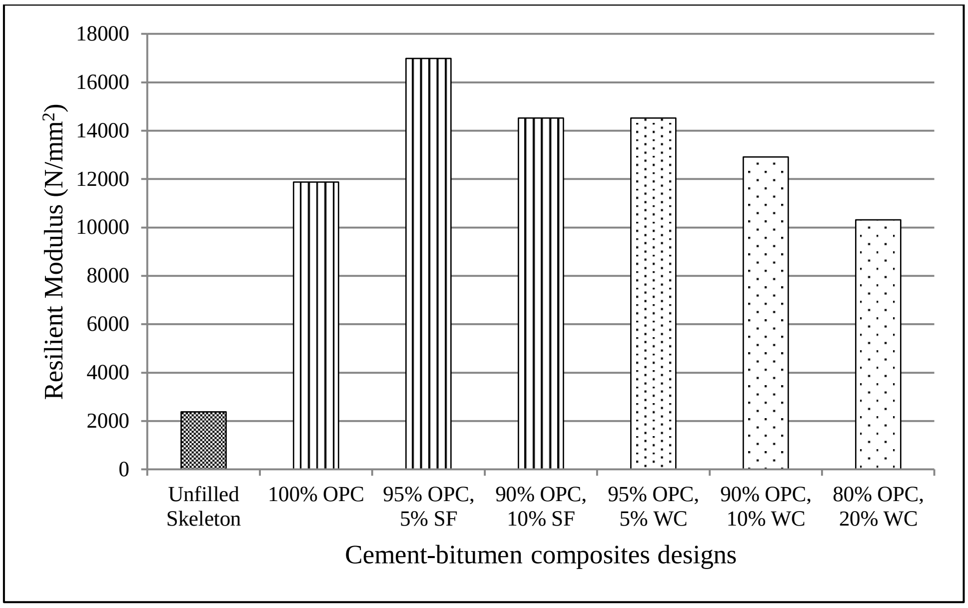

Figure 5.4: Indirect Tensile Stiffness Modulus Performance for Different Cement-Bitumen Composites

The highest resilient modulus value was 16516 N/mm^2, which is produced by 95% OPC, 5% SF and the lowest resilient modulus value was 2380 N/mm^2, which is produced by unfilled asphalt skeleton samples. The compressive strength of cement-bitumen composites containing 5% SF increased 6 to 10 times as compared to unfilled asphalt skeleton performance. The cement-bitumen composites containing 20% WC replacement produced slightly lower value as compared to 100% OPC mixtures, apparently due to the stickiness and rapid hardening effect of WC. Meanwhile, the cement-bitumen composites containing 5% and 10% SF produced higher resilient modulus as compared to OPC mixture and WC mixtures. Based on the findings, different cementitious grout mixture designs influenced the resilient modulus performance.

(iv) Resistance to abrasion

The Cantabro test is carried out as a preliminary investigation. The test is performed in order to measure the resistance to ravelling of the mix. The mean value of air abrasion loss achieved by unfilled asphalt skeletons and different composition of cement-bitumen composites are compared. The maximum permissible air abrasion loss is considered as 25%, which is a typical value used by the other researchers (Katman, 2006). However, the maximum value of air abrasion loss for open graded asphaltic concrete (which refer to cement-bitumen composites in this study) as stated in DBKL specification, (2003), is should be less than 15% from the original weight of sample. Therefore, the results of the air abrasion loss obtained from this study is compared with both references as stated above. The result of this test is presented in Figure 5.5.

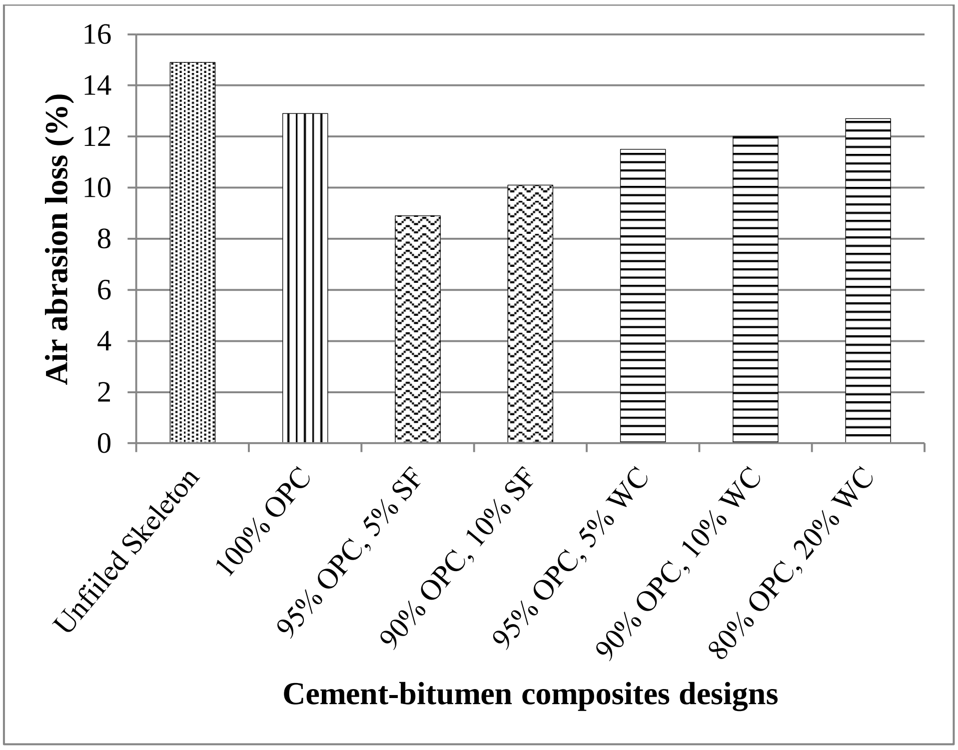

Figure 5.5: Resistance to Abrasion for Different Cement-Bitumen Composite Designs

Based on Figure 5.5, it was exhibited that the inclusion of 5% SF lowers the air abrasion loss of cement-bitumen composites as compared to unfilled asphalt skeleton and cement-bitumen composites containing 100% OPC and different percentages of WC. The highest air abrasion loss value was 14.9% produced by unfilled asphalt skeleton. The replacement of 5% to 20% WC in the grout mixtures exhibited slightly higher air abrasion loss as compared to cement-bitumen composites containing SF and lower values as compared to cement-bitumen composites containing OPC and unfilled asphalt skeleton. This in agreement with the compressive strength performance and air void analysis of cement-bitumen composites. The addition of SF in the cementitious grout mixes had increased the strength of the cement-bitumen composites and hence increases its abrasion resistance. Based on *t*-test analysis, it is found that 95% OPC, 5% SF with 2.0% SP mixture is influenced the air abrasion loss performance of cement-bitumen composites. The *t*-test analysis yielded a t_{stat} value of 27.00 (t_{stat} = 27.00 > $t_{critical}$ = 12.71, Reject H_0) which was significant even at the 0.05 level (p = 0.0236). It can be safely concluded that replacing 5% silica fume in grout mixture is influenced the air abrasion loss performance of cement-bitumen composites. This is probably due to fine particles of silica fume which can penetrate more easily onto the surface of unfilled skeletons.

(v) Static Load Asphalt Creep Test Result

The static load asphalt creep test is performed in the study as a preliminary investigation. The test was conducted using the Universal Material Testing Apparatus (UMATTA). It is carried out in order to characterize permanent deformation resistance of the grouted pavement mixes. The test is carried out at 40°C. The creep modulus of the cement-bitumen composites was determined by dividing loading stress of the sample with the loading strain. Six samples of cement-bitumen composites for two different proportions (3 samples each) are tested for creep performance. Three samples are containing grout mixture with 95% OPC, 5% silica fume, 2.0% SP, 0.30 w/c ratio and another 3 samples are containing 100% OPC, 2.0% SP and 0.30 w/c ratio. The results obtained is tabulated in Table 5.6 and Figure 5.6.

Table 5.6: Creep Modulus of Grouted Pavement Mixes

Mixtures	Creep Modulus at 40°C (N/mm^2)
Cement-Bitumen Composites 1 (95% OPC, 5% silica fume, 2.0% SP, 0.30 w/c ratio)	54.0 (average)
Cement-Bitumen Composites 2 (100% OPC, 2.0% SP, 0.30 w/c ratio)	37.7 (average)

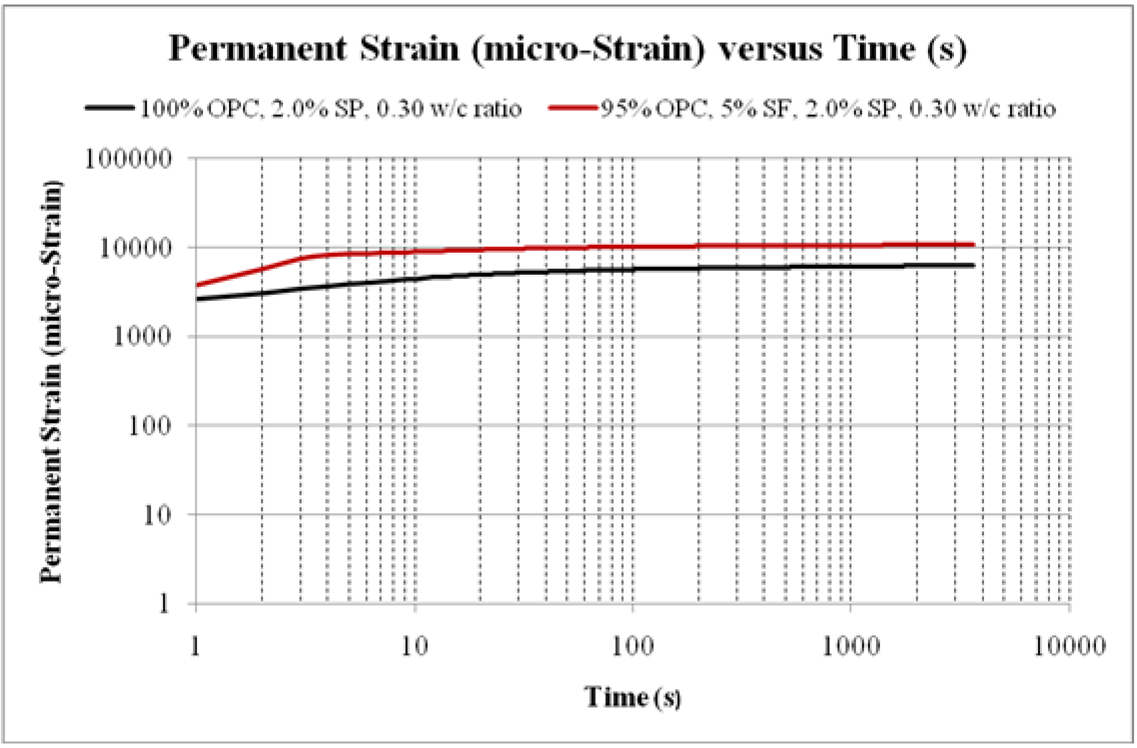

Figure 5.6: Permanent Strain (micro-Strain) versus Time (seconds) for Cement-Bitumen Composites

It shows that the cement-bitumen composites containing 95% OPC, 5% SF gave higher creep stiffness values than that of 100% OPC mixture. The average creep modulus of cement-bitumen composites containing silica fume is 54.0N/mm^2 and 37.7N/mm^2 for cement-bitumen composites containing 100% OPC. The cement-bitumen composites containing silica fume shows a larger amount of permanent deformation than 100% OPC, which indicates a higher rutting potential. However, the result obtained is a pleminary investigation and no exact conclusion can be made on the influences of cementitious grouts on the asphalt mixtures performance. More samples of cement-bitumen composites can be tested in the future in order to investigate the influences of different cementitious grout proportions to resist the permanent deformation.

5.5 Conclusion

The following conclusions were made based on the results from the laboratory investigation;

1. In this study, high workability and high strength cementitious grouts that can infiltrate into open graded asphalt skeletons were produced. It was discovered that the properties of cementitious grout mixtures are influenced by water/cement ratio, superplasticizer percentages and types of cementitious materials used.

2. The air voids content of open graded asphalt skeleton was recommended between 25% to 30%. Although the skeleton has high air voids content, it was able to maintain a thick binder coating on the aggregates at the same time.

3. The cement-bitumen composites (semi-flexible pavement surfacing prototypes) were produced by using appropriate proportions of cementitious grout mixtures and open graded asphalt skeletons.

4. A close relationship between air void content and workability performance of cementitious grout mixtures was indicated. Higher workability performance allows more grouts to fill voids between the aggregate and finally reducing the air voids content in the cement-bitumen composites (semi-flexible pavement surfacing).

5. The cement-bitumen composites containing 5% silica fume replacement showed the highest compressive strength performance at 1 and 28 days. This indicated that the

cementitious grout mixtures with highest compressive strength performance at 1 and 28 days will not necessarily produced the highest compressive strength performance of cement-bitumen composites. In other words, the compressive strength of cementitious grout mixtures showed no relationship with the compressive strength of cement-bitumen composites as a final product.

6. The cement-bitumen composites with 5% replacement of silica fume showed the highest resilient modulus and resistance to ravelling as compared to other mixture proportions.

7. The replacement of 5% silica fume with adequate amount of superplasticizer was considered in development of cementitious grout mixtures in order to produce sufficient performance of cement-bitumen composites (semi-flexible pavement surfacing) as a final product.

As a conclusion, it is recommended to use 95% OPC, 5% SF with 0.30 w/c ratio and 2.0% SP mixture as sufficient and satisfied cementitious grout design in order to obtain desirable properties of cement-bitumen composites. The design incorporated well with open graded asphalt skeleton and producing better performance as compared to other designs. The cement-bitumen composites containing 95% OPC, 5% SF with 0.30 w/c ratio and 2.0% SP mixture shows good performance in air void analysis, compressive strength test, resilient modulus test, abrasion loss test and static load asphalt creep test. The cementitious grout mixture for this design also performed well in workability, compressive strength and flexural strength analysis. It is also recommended that the optimum binder content to sufficiently coat an open graded asphalt skeleton is 3.62%.

Finally, the research objective 5 is achieved by means of a laboratory and experimental works where the influence of a number of independent variables i.e. water/cement ratio, type of SPs, percentages of SPs and replacement of different cementitious binder on performance criteria are assessed.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Introduction

In this chapter, all the findings are relate to the conceptul framework as explained in section 1.6, Chapter 1. This chapter also points to directions for future research in related fields who are considering to carry out similar studies by highlighting the current research limitation. The contributions of the study to the body of knowledge and practices are also explained in this chapter. The chapter concludes by highlighting the conclusions of the whole research, in a brief form.

6.2 Proposed Framework

This section proposes a framework in fulfilment of the research aim and evaluate the current access condition from home to rail station in Klang Valley. The framework in This framework emerges from the intial conceptual framework in Chapter 1, section 1.6. Based on the the findings from each analysis related to focus group, i.e. (1) frequent rail users and (2) private transport users, the framework is refined as depicted in Figure 6.1. The distributions of access trip pattern from home to station experienced by frequent rail users were obtained and discussed as well as travel pattern of private transport users. The findings which are related to access and trip pattern is summarized in sub-section 6.1.2.

In the framework, the frequent rail users and private transport users showed preference to shift to private transport/rail transit with respect to different hypothetical scenarios increment. In other words, any increment or huge changing from their current travel spending or experiences will highly influenced the users' decision in the future. Therefore, research hypotheses for each hypothetical scenario increment were supported.

The shifting probability to other travel mode choice preference if the other mode become more favourable was sumamrized in sub-section 6.1.2 and 6.1.3.

The specific analysis for each access mode indicator also showed meaningful findings in determining the strength and flaws of the current access mode condition. The improvement on the indicators that should be highly prioritized were obtained and appropriate steps can be proposed. The summary of access mode indicators that should be highly prioritized was summarized in sub-section 6.1.5.

The structural model for perceived importance of rail transit system traits was also established. The summary of each relationship in the measurement and structural model was summarized in sub-section 6.1.7. In general, based on the framework, the future plans on better accessibility environment can be modelled to give pleasant travelling experience to the users.

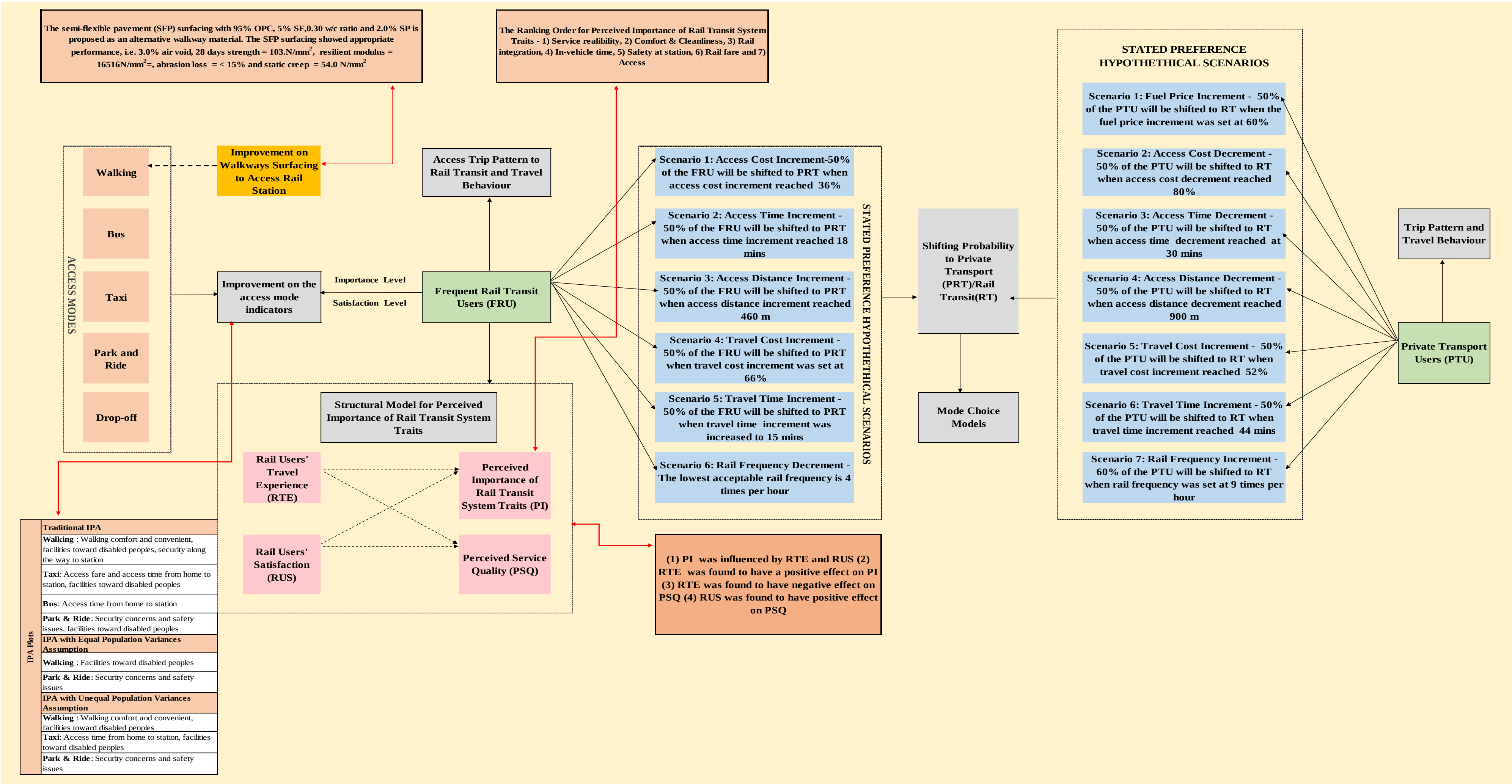

Figure 6.1: The Proposed Framework for Evaluating and Improving the Accessibility to Rail Transit Station

6.3 Achievement of the Research Aim and Objectives

This study developed seven research objectives (refer to Section 1.4 in Chapter 1) with the formulation of nine research questions (refer to Section 1.5 in Chapter 1). The first, second and third research question is related to the discussion on the daily access trip and travel pattern of frequent rail users and private transport users. The fourth and fifth research question investigated the potential of frequent rail users and private transport users to shift to private transport/ rail transit under different hypothetical scenarios. The sixth research question is related to the current access mode indicators that should be prioritized in order to improve the rail station accessibility. The seven research question is about the walking surface quality for pedestrian to access rail station from home. Meanwhile, the eight research question is related to rail transit system traits that is of importance and priority to frequent rail users. Finally, the last research question is related to the development of structural equation model for perceived importance of rail transit system.

The data was collected through questionnaire survey. The on-field survey was carried out in various rail transit system in Klang Valley (KV). The achievement of the research obejctives will be further expanded on in hereafter sub-sections, i.e. 6.3.1 until 6.3.6.

6.3.1 Research Objective 1 (RO1): To identify and discuss the access trip pattern to rail transit station as well as travel behavior of frequent rail transit users and private transport users in Klang Valley, Malaysia.

With respect to this objective, the access and trip patterns of frequent rail users and private transport users were investigated and summarized. The access and trips patterns involved analysis of the overall travel time, overall travel cost and overall travel distance from home to final destination as well as access cost, access time, access distance and access mode from home to rail station. With respect to access cost, 33.8% of frequent rail users do not incurred any cost for their access trip because they were walking to rail station. However, by excluding those who are walking to rail station from home, frequent rail users spent in average RM2.30 for their access cost. It was discovered that frequent rail transit users taking in average 12 minutes to reach rail station from home using various access modes. It was also discovered that walking and drop-off are preferable if access time is within 5.0 minutes. As access time increased until up to 10 minutes, taxi, and park and ride mode options increased. The access distance had a negative effect on a walking to rail station because the longer the access distance from rail station is the less likely the travellers is willing to walk. This study has found that walking to rail station was a dominant mode for an access distance of lesser than 1000 metres. The findings of this study suggest 500 meters as a demarcation line of walking mode with other access modes to the rail station in Klang Valley. For overall travel cost, frequent rail users spent RM7.60 in average from home to their final destination and the return journey. In average, the overall travel time of frequent rail users to travel from home to final destination was 91 minutes. Other than that, more than one third (32.2%) of frequent rail users travelled more than 30 km per day from home to the final destination and for the return journey.

With respect to access mode, it was summarized that walking to rail station was the dominant access mode among frequent rail users in Klang Valley with the percentage of 33.8%. The present study confirmed the previous findings (Rastogi & Rao, 2003; Givoni & Rietvield, 2007; Wibowo & Chalermpong, 2010) and contributes additional evidence that suggests the significance role of walking facilities and environment in influencing the public transport services landscape especially in the emerging countries. One of significant findings that emerge from this study is that majority (56.6%) of frequent rail users will use private transport as an alternative travel mode if rail was not chosen as their daily travel choice. However, 43.4% of frequent rail users were still considering another public transport, namely, bus and taxi, as their alternative daily travel mode. It was also shown that about 46.4% of frequent rail users who walked to station would use their private transport as their alternative travel mode. Although all the frequent rail users have available vehicle for the journey, the evidence from this study suggests that availability of cars does not have a strong effect on the choice of access mode to the station, and availability of cars does not necessarily mean the rail is not the preferred choice of mode to get to the workplace. Nevertheless, these findings also suggest a role of vehicle availability factor in promoting more usage of rail transit and to increase daily rail ridership.

The park and ride facility was the major (50%) access mode that private transport users choose when they travelled by rail. Meanwhile, the use of public transport, namely, bus and taxi showed lower preference as compared to other modes. In average, private transport users spent RM2.70 by excluding those who are walking to rail station from home. In average, private transport users took 15 minutes to reach rail station from home as compared to frequent rail users. Majority of private transport users (41.5%) stayed in access distance of more than 2km from rail station. The present study has shown that the private transport users spent RM15.40, which was RM7.80 higher than frequent rail on their daily travel cost (including the return journey). With regard to travel time, 74.8% of the frequent rail users took more than 60 minutes to travel from home to final destination as well as for the return journey. In average, the overall travel time was 97 minutes, which was 8 minutes higher than frequent rail users. With respect to access distance, majority of private transport users travelled more than 40km for their trip to and from the destination. However, it was encouraging to discover that about 85.0% of private transport users will use rail as their alternative daily travel mode.

This study also found that in general there were four major factors that influenced frequent users to travel by rail transit daily. Those four factors were fastness (84.6%), security (80.9%), affordability (79.1%) and accessibility (79.1%). With regards to the access modes patterns findings, the unavailability of the vehicle (53.2%) is the least agreeable factor that influenced frequent users to travel by rail transit daily. This study also shown that there were six factors achieved more than 50% of 'strongly agree and agree' rate which influenced private transport users travel daily with their vehicles. The factors were flexibility (72.3%), convenience and comfort (62.0%), working purpose (61.2%), route outside rail coverage (58.1%), more transfers when using rail (56.0%) and safety factor (53.4%).

The current rail transit performance evaluated by frequent rail users has shown that ticket fare was ranked as the highest (59.7%) in terms of 'Very good' and 'Good' as compared to other current satisfaction measurement. The customer service and management of complains was ranked at the lowest performance (10.2%) by frequent rail users. The private transport users ranked the comfortability in the rail and at the station as the highest (57.3%) in terms of 'Very good' and 'Good' as compared to other attributes. However, the private transport users ranked safety at station and inside rail transit as the lowest satisfaction (15.4%) as compared to other attributes.

The results of this investigation show that there is a different view between frequent rail users and private transport users in perceiving the most concerned factors that will influence them when using rail transit system. According to frequent rail users, three factors were rated more than 90.0%. The factors were safety at station and inside rail (92.6%), service reliability (92.0%) and rail fare (90.8%). However, private transport users were reflected more on service reliability (91.1%) as the most important factors which will influence them to use rail as daily travel mode. Through related statistical analysis, the frequent rail users highlighted rail fare more importantly as compared to private transport users. An implication of these are the possibility to further look into this difference is imperative especially in providing better rail services by considering feedback on what are the most concerned attributes that will influence travellers when using rail transit system and to give better perception in encouraging voluntary initiative among private transport users to travel by rail transit.

6.3.2 Research Objective 2 (RO2): To investigate the influence of access and travel attributes as well as socio-demographic factors on the willingness of frequent rail transit users travel consistently by rail and the potential of frequent rail transit users shifting to private transport

In order to achieve this objective, six hypotheses were derived. The summary and suggesting implications for each hypothesis were presented below:

Hypothesis 1 assumed that there was significant relationship between socio-demographic characteristics and access cost increment with probability of shifting to private transport mode. The result provided empirical support for the hypothesis with binomial regression analysis showing that there were five predictor variables, namely, incomes, license availability, vehicle availability, travel purpose and access cost increment which was found to be significant at least at the 0.05 level. One of the significant findings emerged from this study is that frequent rail users who used rail transit for work were less likely to shift to private transport with respect to access cost increment. The study has shown that frequent rail users treated 36% as the maximum increment of current access cost that they will tolerate before the likelihood to shift to private transport increased gradually and likelihood to travel with rail decreased continuously. It was also reported that the frequent rail users will fully consider shifting to rail transit if the access cost was increased to 100% from their current access cost expenses. The evidence from this study suggested that any access cost increment in the future will strongly affect the frequent rail users decision on their daily travel mode. This research can be served as a basis for future studies in assisting transport planners and service operators to propose affordable access cost from home to rail station, which tenable for rail transit users.

Hypothesis 2 assumed that there was significant relationship between socio-demographic characteristics and access time increment with probability of shifting to private transport mode. The result provided empirical support for the hypothesis with binomial regression analysis showing that there were three predictor variables, namely, income, travel purpose and access time increment that were found to be significant at least at the 0.05 level. With respect to this hypothesis, this study has shown that the travellers with higher income were less sensitive to travel fares, and is willing to spend more as long as they arrive punctually at their work place. Based on the shifting probability findings, 18 minutes increment from their current access time was considered as a maximum access time increment that frequent rail users will tolerate before they gradually shifting to private transport mode. It was also shown that shifting probability to private transport reached 100% when access time increment increased to 60 minutes. The evidence from this study suggested that frequent rail users are vulnerable towards access time increment.

Hypothesis 3 assumed that there was significant relationship between socio-demographic characteristics and access distance increment with probability of shifting to private transport mode. The result provided empirical support for the hypothesis with binomial regression analysis showing that there were five predictor variables, namely, gender, access mode, vehicle availability, travel purpose and access distance increment that were found to be significant at least at the 0.05 level. This study has found that any access distance increment might not bring huge influence on the frequent rail users who are using motorized access modes to rail station. The results also indicated the importance role of vehicle availability factor in influencing frequent rail users decision because it was shown that the frequent rail users will travel consistently by rail and will use their private vehicles as access modes or will use the drop-off facilities at the rail station if access distance is about to increase. Based on the shifting probability findings, 460m was suggested as maximum access distance increment that frequent rail users will tolerate before they shift to private transport mode continuously. It was also shown that shifting probability to private transport reached 100% when access distance increment increased to 1000m.

Hypothesis 4 assumed that there was significant relationship between socio-demographic characteristics and travel cost increment with probability of shifting to private transport mode. The result provided empirical support for the hypothesis with binomial regression analysis showing that there were five predictor variables, namely, gender, access mode, vehicle availability, educational level and travel cost increment that were found to be significant at least at the 0.05 level. In contrast with access distance increment, frequent rail users who are using motorized access mode to reach rail station were two times more likely to shift to private transport mode if travel cost are about to increase. An implication of this is the possibility that any travel cost increment will involve the access cost increment, rail ticket fare, fuel price, taxi fare, bus fare, parking rate and probably egress fare, which would influence the frequent rail users in a long run and eventually will affect the rail transit system indirectly. Thus, it can be inferred that frequent rail users were highly influenced by the increase of travel cost rather than access cost. Based on the shifting probability findings, 66% increment from their current travel cost is suggested as the maximum travel cost increment that frequent rail users will tolerate before they shift to private transport mode and their likelihood to travel by rail decrease continuously. The present finding on travel cost increment noted several noteworthy contributions to be proposed as an important indicator to transport planners and service operators in deciding affordable travel cost for rail users.

Hypothesis 5 assumed that there was significant relationship between socio-demographic characteristics and travel time increment with probability of shifting to private transport mode. The result provided empirical support for the hypothesis with binomial regression analysis showing that there were five predictor variables, namely, access mode, age, license availability, educational levels and travel time increment that were found to be significant at least at the 0.05 level. One of the more significant findings to emerge from this study is that elderly commuters were less likely to shift to private transport mode than younger rail users with respect to travel time increment. The evidence from this suggested that convenience and user friendly design of facilities to sufficiently cater public transportation services to all age groups should be highlighted. Based on shifting probability, frequent rail users were highly influenced by travel time increment. The study has shown that 50% of frequent rail users considered shifting to private transport mode with 15 minutes increment from their current travel time.

Hypothesis 6 assumed that there was significant relationship between socio-demographic characteristics and rail frequency decrement with probability of shifting to private transport mode. The result provided empirical support for the hypothesis with binomial regression analysis showing that there were three predictor variables, namely, access mode, license availability, educational levels and rail frequency decrement that were found to be significant at least at the 0.05 level. Contrary to expectation, the frequent rail users were less likely to shift to private transport mode by rail frequency decrement. However, it was identified that in the stated preference scenario design, the rail frequency was assumed to decrease from 8 times per hour (7.5 minutes headway) to 3 times per hour (20 minutes headway). Therefore, frequent rail users are still willingly to consider travel by rail because currently the lowest rail frequency is 4 times per hour (15 minutes headway) in Klang Valley, which was operated by KTM Komuter System. Based on shifting probability, it was discovered that the likelihood of shifting to private transport increased from 17.0% to 97.0% when the rail frequency was decreased from 7 times until 3 times per hour. The evidence from this study suggested how influential the rail regularity to frequent rail users are.

6.3.3 Research Objective 3 (RO3): To investigate the influence of access and travel attributes as well as socio-demographic factors on the willingness of private transport users travel consistently using private vehicle and the potential of private transport users shifting to rail transit

In order to achieve this objective, seven hypotheses were derived. The summary and suggesting implications for each hypothesis were presented below:

Hypothesis 1 assumed that there was significant relationship between socio-demographic characteristics and fuel price increment with probability of shifting to rail transit mode. Four predictor variables, namely, access mode, income, vehicle and fuel price increment were found to be significant at least at the 0.05 level. One of the significant findings emerged from this study is that private transport users with higher monthly income were more sensitive towards fuel price increment, which indicated that as fuel price increased, private transport users were more likely to shift to rail transit mode. Moreover, the evidence from this study suggested that any increment in driving cost particularly the fuel price, will become a strong deterrent to private transport users because any fuel price increment will directly influence their overall travel cost. In summary, the empirical findings in this study provided a new understanding on travel behaviour of private transport users. The study has shown that 50% likelihood of shifting to rail transit might be achieved when the fuel price increment was set at 60%. Taken together, this finding can be proposed as an important indicator to implement a new policy or system because any increment in current fuel price will likely encourage more private transport users to shift to rail transit.

Hypothesis 2 assumed that there was significant relationship between socio-demographic characteristics and travel cost increment with probability of shifting to rail transit mode. Two predictor variables, namely, gender and travel cost increment were found to be significant at least at the 0.05 level. The study has shown that private transport users were found to be less sensitive with respect to travel cost increment. The findings of this study suggested that private transport users have a higher tendency to maintain with the past choice even though another alternative offers more appealing scenario (inertia effects). Based on shifting probability, the 100% shifting to rail transit would be achieved at 130% increment from their current travel cost. This finding has shown that private transport users have strong desire to continue travelling with their owns' vehicle despite of higher travel cost. The results of this study indicated that private transport users are willing to trade-off higher travel cost in order to obtain comfortability, convenience and flexibility that travellers experienced when taking private transport as their daily mode.

Hypothesis 3 assumed that there was significant relationship between socio-demographic characteristics and travel time increment with probability of shifting to rail transit mode. Three predictor variables, namely, age, vehicle availability and travel time increment were found to be significant at least at the 0.05 level. One of the important highlight was the willingness of elderly commuters to shift to rail transit mode than younger rail users by travel time increment. Therefore, convenience and user friendly facilities design at the station and inside rail should be focused to sufficiently cater public transportation services to all ages. Based on shifting probability, 50% of private transport users will shift to rail transit by 44 minutes increment from their current travel time. The private transport users would completely shift to rail transit mode by increment of 60 minutes from their current travel time. The study has shown that current private transport users were struggling in terms of their travel time but still continue travelling by private transport because of unreasonable travel time and too many transfers which identified as the strong deterrent for them while using rail transit.

Hypothesis 4 assumed that there was significant relationship between socio-demographic characteristics and access cost decrement with probability of shifting to rail transit mode. Two predictor variables, namely, vehicle availability and access cost decrement were found to be significant at least at the 0.05 level. Based on shifting probability, 50% of private transport users will shift to rail transit by 80% of access cost decrement. Taken together all the findings, the study has shown that private transport users were hardly shifted to rail transit even though they have had experience travel by rail at least once in 2 months.

Hypothesis 5 assumed that there was significant relationship between socio-demographic characteristics and access time decrement with probability of shifting to rail transit mode. Four predictor variables, namely, license availability, vehicle availability, travel purpose and access time decrement were found to be significant at least at the 0.05 level. Based on shifting probability, 100% of private transport users will shift to rail transit when access time decreased 1.5 hours from their current access time. The study has shown that private transport users are vulnerable towards access time because any access time increment or decrement will affect the overall travel time.

Hypothesis 6 assumed that there was significant relationship between socio-demographic characteristics and access distance decrement with probability of shifting to rail transit mode. Two predictor variables, namely, license availability and access distance decrement were found to be significant at least at the 0.05 level. The study has shown that 50% of private transport users will strongly incline to rail transit mode when access distance decrement reached 900m. In addition, 100% of private transport users will shift to rail transit if their current access distance were decreased about 2000m. The results of this investigation suggest that private transport users will fully utilized the park and ride facilities in the station if they shift to rail in the future, which would benefit commuters with vehicle availability.

Hypothesis 7 assumed that there was significant relationship between socio-demographic characteristics and rail frequency increment with probability of shifting to rail transit mode. Three predictor variables, namely, license availability, and rail frequency increment were found to be significant at least at 0.05 level. Based on shifting probability, 95% of private transport users will shift to rail transit when the rail frequency was set at 12 times per hour (5 minutes per arrival). The study has greatly contributed towards understanding of how influential of rail regularity to private transport users in order to encourage them to use rail transit voluntarily and more frequently.

6.3.4 Research Objective 4 (RO4): To identify and investigate the current access modes indicators that are priorities for enhancement and thus allow for the implementation of direct strategies which are based on the quality performance and importance level

In order to achieve this objective, three different Importance-Performance Analysis (IPA) methods were applied. The methods were (1) Traditional IPA, (2) IPA with Equal Population Variances Assumption and (3) IPA with Unequal Population Variances Assumption. Both methods 2 and 3 were integrated with confidence intervals. In the Importance-Performance Analysis (IPA) with integrated confidence intervals, the variation of point estimation and the consideration of variability or sampling error are taken into consideration. Therefore, any indicators which were located in two-dimensional matrix in the coordinate systems of Importance-Performance Analysis (IPA) with integrated confidence intervals are considered to be more effective as compared to traditional IPA.

For this measurement, 37 accessibility service quality attributes for five different access modes in Klang Valley were investigated. The service quality attributes were used to measure or perceive performance of access modes conditions from the user's point of view. The access modes were walking, taxi, bus, park and ride and drop-off. In this analysis, the access modes indicators which were located in Quadrant IV: Concentrate Here placed as a highest priority to be improved because those indicators are the major weakness of the system. The access mode indicators that lie in this quadrant are the priority in order to maintain the interest among the users and attract non-users to consider using the rail voluntarily as their daily travel mode. The summary of all the indicators for five major access modes, which were located in quadrant QIV was tabulated in Table 6.1 below.

Table 6.1: Summary of Access Modes Indicators Located in Quadrant QIV

<table>
<tr><th>IPA Plots</th><th>Access Mode Indicators</th></tr>
<tr><td rowspan="14">Traditional IPA</td><td>Walking</td></tr>
<tr><td>W2.Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)</td></tr>
<tr><td>W9.Facilities toward people with disabilities</td></tr>
<tr><td>W10.Security along the way to station</td></tr>
<tr><td>Taxi</td></tr>
<tr><td>T1. Access fare from home to station.</td></tr>
<tr><td>T2. Access time from home to station.</td></tr>
<tr><td>T8. Facilities toward people with disabilities.</td></tr>
<tr><td>Bus</td></tr>
<tr><td>B2. Access time from home to station.</td></tr>
<tr><td>Park and Ride</td></tr>
<tr><td>P5.Security concerns and safety issues (guarded parking space, etc.).</td></tr>
<tr><td>P6.Facilities toward disabled peoples.</td></tr>
<tr><td rowspan="4">IPA with Equal Population Variances Assumption</td><td>Walking</td></tr>
<tr><td>W9.Facilities toward people with disabilities</td></tr>
<tr><td>Park and Ride</td></tr>
<tr><td>P5.Security concerns and safety issues (guarded parking space, etc.).</td></tr>
<tr><td rowspan="8">IPA with Unequal Population Variances Assumption</td><td>Walking</td></tr>
<tr><td>W2.Walking comfort and convenient (obstructions e.g. posts, trees, benches, etc.)</td></tr>
<tr><td>W9.Facilities toward people with disabilities</td></tr>
<tr><td>Taxi</td></tr>
<tr><td>T2. Access time from home to station.</td></tr>
<tr><td>T8. Facilities toward people with disabilities</td></tr>
<tr><td>Park and Ride</td></tr>
<tr><td>P5.Security concerns and safety issues (guarded parking space, etc.).</td></tr>
</table>

It was summarized that facilities toward disabled peoples became a crucial concern with respect to all access modes indicators, which were located in quadrant QIV. In addition, safety issues also became a concern especially to frequent rail users who access rail station by park and ride mode. These two indicators appeared in each IPA Plots despite of different variances assumption. Interestingly, commuters who accessed rail station by taxi, highlighted access time as indicator that should be improved in Traditional IPA and IPA with Unequal Population Variances Assumption. For walking mode, commuters perceived the walking comfort and disable facilities as the indicators that should be prioritized on if the authorities or service operators want to make frequent rail users to travel with rail consistently. This finding had been pointed in Urban Rail Development Plan (Land Public Transport Commission, 2013b) which proposed that each of transit stop should be served by a walking catchment, namely 400 metres for outdoor pathway and over 400 metres for indoors pathway. In other words, walking to rail-based transport services has a potential as the dominant access mode in the future if walking environment and facilities are greatly improved.

As a comparison, it was discovered that there were three access mode indicators, namely, T1: Access fare from home to station, B2: Access time from home to station and P6: Facilities toward disabled peoples were not considered as indicators that should be prioritized on when 95% confidence intervals with Equal and Unequal Population Variances Assumption was applied in Importance-Performance analysis. Whereas in Traditional IPA, these three access modes indicator were considered as important parameters that should be prioritized. Therefore, the philosophy of using confidence intervals in IPA was achieved by reducing the sampling variability and assists the decision maker to make effective judgments under two different types of population variances assumptions.

As a summary, the access mode indicators as listed in Table 6.1 are the most crucial parameter to be prioritized from frequent rail users point of view and other service quality indicators might have a higher priority from the service operators and policy makers views. It was believed that these findings is very useful for system managers and decision makers, as it indicates which indicators or parameters that should be prioritized in order to improve the quality of the rail-based transport system as the sustainable way of travelling.

6.3.5 Research Objective 6 (RO6): To evaluate the rail transit system traits that is of importance and priority to frequent rail users

In this objective, each indicator of perceived importance construct was compared. There were seven indicators or observed variables in perceived importance construct. After SEM analysis, the ranking order of seven indicators based on the prority is summarized in Table 6.2.

Table 6.2: The Ranking Order for Perceived Importance of Rail Transit System Traits

Rail Transit System Traits/Indicator	Regression weight, β
1. Service realibility	0.81
2. Comfort and cleanliness	0.77
3. Rail integration	0.74
4. In-vehicle time	0.72
5. Safety at station	0.71
6. Rail fare	0.67
7. Access	0.53

Based on Table 6.2, it was discovered that service reliability is rated as the highest priority as compared to other rail transit system traits. In comparison, service reliability indicator explained about 16.4% of the total standardised regression weight, which was slightly higher than other perceived importance traits. This is followed by comfort and cleanliness, rail integration, in-vehicle time, safety at station, rail fare and access. It was interesting to summarize that easy access to rail transit system was rated as the lowest priority as compared to other rail transit system traits. This finding suggested that, the rail users' in Klang Valley were prioritized more on service reliability, and accessibility to rail transit system was considered the least priority in the final structural model. These findings have enhanced our understanding of the important roles of vehicle availability and good walkways facilities to reach rail station from home. All the frequent rail users have available vehicles for the journey, either of their own or their household vehicles. This study indicated that providing more park and ride facilities in the rail station and proper drop-off area would likely to encourage more travellers to use rail transit as their daily travel mode. Meanwhile, proper and tenable walkways facilities should be provided because walking was found as dominant access mode for shorter access distance, which was between 0 to 500 metres.

6.3.6 Research Objective 7 (RO7): To develop the structural equation model for perceived importance of rail transit system traits

With respect to objective seven, this research was managed to develop the structural equation model for perceived importance of rail transit sytem traits as depicted in Figure. The final structural model to evaluate perceived importance of rail transit system traits was depicted in Figure 4.72.

Referring to the hypothesis stated at the beginning of this study, it is now possible to summarize that perceived importance of rail transit system traits was influenced by rail users' travel experience and perceived service quality. However, the perceived importance of rail transit system traits was not influenced by the rail users' satisfaction. It was important to highlight the significant influence of service quality and rail users' experience on the rail users' satisfaction while travelling by rail. It was also important to summarize and highlight that the current frequent rail users are struggling in terms of their travel cost, travel time, and travel distance. It was also concluded that the frequent rail users were more sensitive towards travel cost as compared to travel time and travel distance. Finally, it was summarized that there was a positive correlation between (1) comfort and rail safety satisfaction, and (2) between frequency and rail fare. This is because the frequent rail users felt more comfortable travelling by rail as rail safety level increased. At the same time, the frequent rail users felt more satisfied about the rail fare if the rail frequency increased in the future.

It was also summarized that rail users' travel experience was found to have a positive effect on perceived importance of rail transit system traits. The present study confirmed previous finding by Fillone et al., (2005) and contributed additional evidence that suggest the frequent rail users who travelling in a longer travel time, far trip distance, and spending higher travel cost, are more likely to understand which rail transit system traits that are of priority to them and highly influence their daily travel to work based on their experience. Therefore, the future plan on the rail transit system development should highlight the needs to provide pleasant experience to the users' while traveling by rail.

6.4 Limitations of the Study

Although the presented results are significant in understanding several issues on rail transit system in Klang Valley, there are several limitations that falls within the intended scope of this study. The first limitation was the data used only involved travellers, which make weekday trips. The travellers, which make weekend trips, are excluded in this study. However, there are travellers, which make trips in the weekend for work, education and other related purposes. These trips could be included or counted as their usual daily trip, which will influence their travel mode choice.

The second limitation referred to travel mode shift finding. As stated earlier in the objective, the comparison of mode shift was done between rail transit and private transport using the binary logit models. In addition, the study was merely conducted on frequent rail users and private transport users in urban area. Therefore, the result is not applicable to different types of travellers, for instance, bus users and travellers who walk to reach their final destination. Therefore, the finding on mode shift is applicable within the studied travel mode. In the mode utility equations, all the increment or decrement of access and travel attributes, namely, access cost, access time, access distance, travel cost, travel time and rail frequency indicated statistical significance with p value of less than 0.05 or at 95% confidence interval. However, only several socio-demographic factors (gender, access mode, age, job status, monthly income, license availability, vehicle availability and educational level) and trips behaviour (travel purpose and number of trips per week) showed statistical significance with p value of less than 0.05 or at 95% confidence interval. Therefore, more samples and further studies on mode shift probability with respect to increment or decrement of related access attributes scenarios could be further explored to have an appropriate combination of variables, which will represent the utility functions.

Although with these limitations, the analysis offers significant information and findings for related parties, such as, transport planners, policymakers and service operators to improve the current conditions of rail transit systems and to develop planning on sustainable transport system in the urban area.

6.5 Contributions of the Study

The contributions from this study is intended to expand the (1) existing body of knowledge, and also (2) to benefit practitioners in the related fields. Each contribution will be discussed in the following sub-sections.

6.5.1 Contribution to the Body of Knowledge

There were four ways that this study contributed to the body of knowledge. The study contributed in (1) case study, (2) current issue, (3) method contribution and (4) model development .

(1) Case study

With respect to case study area, i.e., Klang Valley, previous researches on rail studies (Leong et al., 2009; Waris et al., 2010; Khalid et al., 2014) were mainly focused on the satisfaction and performance of rail services. However, in this study, apart from investigating the rail service performance and satisfaction, the access of trip pattern and its performances as well as its satisfaction on the accessibility from home to rail station was focused and investigated as this issue received less attention and not broadly covered in Klang Valley (KV) despite of its important. The novelty of this research is the accessibility from home to rail station as an important attribute that should be prioritized by the transport planners and service providers to increase rail riderships' in the future. For instance, this research has identified walking as the dominant access mode that the frequent rail users used from home to rail station in Klang Valley area. The contribution is related to Research Objective 1.

In addition, the previous researches (Kamba et al., 2007; Vedagiri & Arasan, 2009; Miskeen et al., 2013) on shifting probability to other travel modes in KV were concentrated more on the influences of travel time and travel cost among commuters/travellers in general and not specifically focused to a particular travel mode users. Meanwhile, this study is specifically focused on the frequent rail users and private transport users in the KV. The shifting probability of frequent rail users from rail to private transport with respect to the increment of access cost, access time, access distance, travel cost, travel time, and decrement of rail frequency was investigated. This research has identified, for instance, maximum value of access cost that frequent rail users would tolerate before they shifted to private transport mode. This study also contributed in giving inputs by considering the shifting probability of private transport users from their own's vehicle to rail transit. The potential of private transport users to shift to rail transit was also being considered as they were occasional rail transit users as well. The shifting probability of private transport users' with respect to fuel price, travel cost, travel time, rail frequency, access cost, access time and access distance was investigated. The contribution is related to Research Objective 2 and 3.

Additionally, there were no specific studies investigated the current satisfaction and the importance of access modes used by frequent rail users in Klang Valley. Previous researches were mainly focused on the rail service performance and improvement on the rail station facilities (Kamaruddin et al., 2012; Khalid et al., 2014; Kumar, 2015). The novelty of this research is the investigation on satisfaction level and evaluation of each access modes attributes that should be prioritized from frequent rail users' point of view and experiences. For instance, the frequent rail users who walked to rail station has determined that walking path quality was an attribute that should be prioritized due to its low satisfaction level, but high importance level. The contribution is related to Research Objective 4.

With respect to the case study area, namely, Klang Valley, the choice of pavement surfacing is usually a flexible pavement while the rigid pavement is not widely used. However, in this study, the introduction of using semi-flexible pavement on walkways surfacing was proposed. Based on the findings, the semi-flexible pavement performance is superior to conventional design pavements in number of criteria. For instance, the use of semi-flexible pavement in the walkways surfacing will provide longer reliability in terms of its load, rutting resistant and less maintenance works. Although the semi-flexible pavement design has been applied in certain areas in Klang Valley, for instance, along Jalan Tunku Abdul Rahman and in front of Kuala Lumpur City Hall, the current semi-flexible pavement design needs some modifications in terms of design and materials due to the climate and thermal expansion of the current design. Therefore, this study contributed in introducing and proposing the semi-flexible pavement as an alternative for the walkways along the stations. The contribution is related to Research Objective 5.

(2) Current issues

With respect to the current literature or issues, Ho et al., (2017a), Ho et al., (2017b), & Baharom (2017) highlighted the needs to have sufficient parking bays in the rail station as a solution to maintain and increase rail transit riderships' in the Klang Valley. However, throughout this study, it was found that providing more parking bays in the rail station is not an effective solution in the long run. This is because, the roads near the rail stations will be congested if the use of Park and Ride mode increased. In addition, the evidence from this study suggested that availability of vehicles does not have a strong effect on the choice of access mode to the station, and availability of cars does not necessarily mean the rail is not the preferred choice of mode to get to the workplace or other places. The improvement on bus service, e.g., providing exclusive bus lanes, shorter waiting time and proper walking path are suggested in order to increase rail riderships' in the long run. The contribution is related to Research Objective 1 and 4.

(3) Method contribution

This study also contributed to the body of knowledge through method appraisal. For instance, Several literatures (Deng et al., 2011;Grujicic et al., 2014; Sever, 2015) addressed the shortcomings of using Traditional IPA approach in analysing the satisfaction and importance level of the offered services. Throughout this study, the application of Integrated IPA with Confidence Intervals (CI) was used to overcome the shortcomings of Traditional IPA. In this study, the Integrated IPA with Confidence Intervals (CI) was used in assisting the service operators and policy makers in prioritising access modes service and facilities to be improved. The contribution is related to Research Objective 4.

(4) Developing a model

This study also contributed to the body of knowledge through structural equation model developement . In the past studies (Rahaman & Rahaman, 2009; Githui et al., 2010; Lai and Chen, 2011; Malik, 2012) have investigated the causal relationship between the users' satisfaction and service quality in rail-based transport service sectors. However, in this study, the proposed structural model is unique because it considers new exogenous variables, (1) rail users' travel experience and (2) perceived importance of rail transit system traits in the causal relationship of (3) users' satisfaction and (4) service quality. It was found that the perceived importance of rail transit system traits (structural model) were influenced by (1) rail users' travel experience (2) perceived service quality and (3) rail users' satisfaction. This finding was contributed in developing new structural model which related to rail-based transport service sectors. The contribution is related to Research Objective 6 and 7.

6.5.2 Contribution to the Practices

The findings from this study could be beneficial to the practitioners, namely, service operators, transport planners, government agencies, local authorities and the commuters as well. This study has addressed accessibility issue and other related issues on rail transit system. The findings from this study could be contributed in several areas as listed below:

1. The findings on shifting probability from rail to private transport mode with respect to changing of access cost, access time, access distance, travel cost, travel time and rail frequency will assist the transport planners and service operators in determining, for

instance, affordable access cost, acceptable access time and appropriate access distance from home to rail station. The data from each travel scenario changing could be regarded as a basis by the practitioners in improving access from home to rail station in the future.

2. This study also contributed in implementing appropriate policies on current fuel price control because any increment will likely encourage more private transport users to shift to rail transit in the future. Based on the finding, the private transport users were vulnerable toward fuel price increment and any driving cost increment particularly the fuel price, will become a strong deterrent to private transport users to consistently travelled by their owns' transport.
3. The findings from the integration of CI in IPA assisted the policy makers and service operators to make effective judgments and to avoid mistakes in choosing the indicators that should be primarily acted on. It was important to identify the appropriate access mode indicators because it will influence the rail users to maintain the interest among the rail users and attract non-rail users to consider using the rail voluntarily as their daily travel mode. The service operators and policy makers can indicate the strength and weaknesses of current access mode services, in order to increase the quality level and access service attractiveness based on urban rail transit users' views, with minimal investment.
4. The proposed design on the surface quality of the walkways will be beneficial for the local authority and transport engineers to provide more accessible environment to pedestrian. The current design of semi-flexible pavements for the walkways is the imported cementitious material and modified polymer bitumen. The use of imported materials will lead to higher installation costs and also maintenance costs in the long run. Therefore, an alternative local product is used and an appropriate design for the surface quality of the walkways was proposed. By using local materials, the

production and maintenance costs will be much lower, economical and competitive than the imported ones. In addition, the existing semi-flexible pavement surfacing was redesigned to be more applicable to local conditions.

5. Finally, this study would contribute valuable inputs on accessibility improvement in Klang Valley, Malaysia and at others Southeast Asian countries which provide urban rail transit system of a similar kind.

6.6 Recommendations

The use of rail transit system is regarded as a sustainable form of transport that can improve the transportation system in Klang Valley, to become more liveable urban area in Malaysia. In order to increase the public transport attractiveness, several planning and policies measured need to be taken and implemented. The suggested policies are,

1. Investment in improving the access to rail transit service

The National Key Results Areas (NKRAS) for Urban Public Transport under Government Transformation Programme 2014 (Performance Management Unit and Delivery Unit, 2014) showed that daily ridership for all rail services rose 23% in 2014 from 2011. The reliability, speed and carrying capacity of the current rail was identified as the factors, which increased the ridership (Performance Management Unit and Delivery Unit, 2014). Based on the findings from this study, the good accessibility to rail transit system is one of the key factors, which influenced the ridership. The mode choice models with respect to different access and travel scenarios indicated the urgency to improve current access facilities and environment. In addition, with respect to budget constraints, it was identified that improvements to the access require fewer resources and more cost effective than improvements to the level of rail service (Givoni & Rietveld, 2007). Through Importance-Performance Analysis integrated with Confidence Intervals and travel behaviour findings, the frequent rail users satisfaction with the rail journey is relatively due to their satisfaction with the current access facilities which have been provided to them and therefore, improving the quality of the access to the railway station is likely to increase rail use. The findings from this study suggest several courses of action in enhancing the current accessibility conditions with respect to different access modes type and environment.

It was discovered that less than two-thirds of the Klang Valley populations reside within a 400 metres walking distance of bus route and rail transit coverage (Land Public Transport Commission, 2013). With related to this study, walking is discovered as the dominant access mode for shorter access distance (< 500 meters). The evidence from this study, indicated the possibility to promote walking as an effective access mode for access distance below 500 metres. This can be achieved by providing better pedestrian facilities along the way to the station. The improvements that can be made are proper walking path, safe and sheltered walkways, providing facilities for the disabled, direct connectivity of pedestrian lines to rail transit station, etc. Another possible policy that can be promoted as an effective access mode from home to rail transit station is the usage of bicycles. Based on the study area, it was found that the bicycle mode is in use by only 0.85% of frequent rail transit users below an access distance of 1,500 metres. Therefore, bicycle is one of the options that could be used by travellers who live within the 1,500 metres radius from the rail stations. This can be achieved by constructing separate bicycle lanes, direct connectivity towards the rail station, proper bicycle rental or storage systems, etc. Despite of its wider coverage, the lower preference to use bus and taxi as access mode to reach rail station is anticipated due to higher vehicle ownership among travellers in the study area. It is believed that by improving the bus service quality and by providing more exclusive bus lanes from residential areas to rail station, will increase the use of buses as a dominant access mode for far access distance (for instance, for access distance of more than 2km). Due to the increasing number of cars registered in Klang Valley (Ministry of Transport, 2015), car availability factor can possibly be one of the ideal access modes to reach rail station. One of the viable approaches is to provide more park and ride facilities at rail transit stations and to charge affordable parking tariff which would benefit commuters with vehicle availability. It was agreed that the trip makers viewed the rail commuter system and its park-and-ride facilities as the better alternative form of transportation than the private vehicles travelling from the suburbs to city centre (Hamid, 2007; Hamid 2011). This suggested policy would lead to less congestion on the streets in the city centre because of the presence of fewer cars. In the long term, it is believed to be able to improve the modal split that favours more of the public transport as the ideal form of sustainable transport system towards reducing urban congestion. The quality of access facilities was found to be even more important for infrequent rail passengers, indicating that improving the access to the rail network has the potential to increase their use of rail and can attract new passengers (Givoni & Rietveld, 2007). Finally, it was believed that the improvement on the accessibility to rail transit station will be a turning point to those who use the rail less frequently, but still have some experience of using it as compared with those who do not use it at all (Wardman & Tyler, 2000).

2. Increase cost of owning the private vehicle

Undeniably, travel by private vehicle is alluring due to its flexibility and comfort factor. Therefore, public transport ridership is unlikely to increase until the comfort and convenience of using public transport making it an attractive alternative to private transport users (Performance Management Unit and Delivery Unit, 2014). With the increasing number of cars registered in KV which is 3.3 times faster than Malaysia's annual growth rate of population, the private vehicle ownership is a decisive factor which influence travel patterns. The massive number of vehicles will bring harm and make the urban city under stress and unliveable. Several related policies should be reviewed in order to minimize the implication from higher private vehicle ownership. The restricted strategies include private vehicle pricing, tax and more strict requirements when registering for private transportation vehicles should be implemented. However, a proper and appropriate strategy should be planned to ensure any increment or restriction on private vehicle ownership would not burden the travellers in the future.

3. **Transforming parking control for private vehicle in the central business district (CBD)**

Transforming parking control for private vehicle in the central business district (CBD) should be implemented as one of the policies to lessen congestion in the city centre. The parking control and managerial initiative on the parking rates needs to be reviewed to ensure the tariff is in line with market and travel demand. The lower parking rates in CBD areas leads to insufficient parking facilities. The enforcement on parking policy needs to reviewed and strengthens to avoid travellers from double parking, waiting in restricted areas and violation of emergency services areas. Other than reviewing parking tariff, a stricter action against parking violators could be implemented.

4. **Planning on land use development to become Transit-oriented development (TOD)**

The Transit-oriented development, or TOD, is an approach to develop the focuses land around a transit station or within a transit corridor. The rule of thumb is that TOD occurs within one-quarter mile, or a five to seven minute walk, of a transit station (Sustainable Cities Institute, 2013). The implementation of TOD areas in Klang Valley will bring more benefits, namely, higher quality of life with better places to live and work, increased transit ridership, reduced household spending on transportation and etc. These benefits are due to the TOD components, which highlighted walkable design for pedestrian, transit station as prominent feature, easy use of bicycles and scooters (green modes) in the design as daily support transport and etc. TOD approach could be implemented in the existing areas or in new development areas. However, several challenges and issues should be taken cautiously in order to implement TOD approach especially in Klang Valley. Among the challenges were to fulfil access distance requirement which is between 200 and 400 metres from public transport services and to tackle a few issues regarding the penetration rate of public transport ratio versus private vehicles. Those issues included the reliability of bus feeder services, punctuality of trains and improvement on certain rail transit system, i.e. KTM Komuter services which by far is the most unreliable train service in Klang Valley where train arrivals keep getting delayed.

6.7 Future Work

The potential future work as extension to this study is described below.

1. Related supplementary studies

Further supplementary studies may be embarked upon to extend beyond the scope of the present study. The related predictive models, which included significance variables from this study, should be included to forecast the influence of new recommended policies on mode shifting behaviour among private transport users in the future research. In addition, psychological factors such as travellers' behaviours should also be included in any future study to investigate whether those factors would contribute to the likelihood of using private transport. In addition, the travel mode choice models in this survey consisted of binary choice set with only two options, namely, rail transit and private transport. In the future, the models could be improved by included more travel mode choice so that multinomial logistic regression or other related mode choice analysis could be conducted.

2. **The inclusion of Behavioural Intention (BI) and Role of Involvement (RI) in the structural model to evaluate the Perceived Importance of rail transit system in Klang Valley**

In the future, extension works on the structural model to evaluate the Perceived Importance of The Rail Transit System in Klang Valley can be carried out. It will be interesting to investigate the Behavioural Intention (BI) of frequent rail users whether to consistently travel with rail transit or to consider other travel mode choice under certain circumstances. It was discussed in several studies (Olsen, 2007; de Ona & de Ona, 2014; Machado-León et al., 2016) that the theoretical framework of service quality - customer satisfaction -behavioural intention relationship will allow service operators to monitor and record passengers' perceptions on the service and at the same time provide rail transit facilities, which meet their requirement and expectation.

3. **To conduct additional study on walking accessibility to rail transit station**

In the future, more research on the potential of walking as the dominant access mode to rail transit station may be carried out. It was found that there was positive relationship between the walking accessibility and the transit ridership (Biba et al., 2010; Houston et al., 2015). Based on the current data, walking to rail station is the dominant access mode (44.9%) to reach rail station from home. By using 500 meters as a demarcation line of walking mode with other access modes to the rail station in Klang Valley, tenable facilities for pedestrian facilities, safe and protected walkways and direct connectivity along the public transport lines should be built. In the public transport studies, the accessibility is associated with the walking distance or walking time. The walking distance of 400 to 800 metres and walking time between 10 to 15 minutes is often applied (Wibowo, 2005). The walking distance or walking time longer than the suggested values is considered as inaccessible public transport service (Wibowo, 2005). However, walking effort to access rail station not only influenced by walking distance but also by the walking route characteristics. The walking route characteristics as tabulated in Table 4.35 could be improved by adding other related parameters such as walkway surface quality, availability for barriers (for wheelchairs and disable persons) and etc. Furthermore, the walking share model could be developed from access mode choice characteristics and later the equivalent walking distance could be also derived from walking share model. In addition, the study on factors affecting walking as a choice to access rail station could be considered in the future.

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