Analysis of parking usage at the park and ride facility in Klang Valley, Malaysia

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Abstract

A parking utilization survey was administered to examine the parking usage at three selected park and ride facilities along the Kelana Jaya LRT Line and Putrajaya Public transportation terminal (Putrajaya Sentral). This study also analyses the existing parking supply and its physical conditions through a parking space inventory survey at the three selected facilities. Parking characteristics such as parking occupancy, parking accumulation, parking turnover and parking duration at each facility were also examined. Findings showed that overall parking utilization pattern was generally high with the occupancy rate of more than 85% (Terminal Putra station) and more than 92% (Kelana Jaya station). However, the Putrajaya Sentral park and ride facility recorded low occupancy rate at multi-storey parking (below 50%) but high occupancy rate at surface parking (85%). Additionally, all park and ride stations were used by long-term parkers (more than 7 hours). The results from this study were found to be comparable with park and ride studies at Shah Alam and Seremban KTM stations and Washington. A high parking demand at the park and ride facility will, eventually, help to achieve the benefits of sustainable transportation. Finally, recommendations to improve parking supply to meet increase in parking demand and conclusions are also drawn.

Keywords: parking, park and ride, utilization, accumulation, occupancy, duration, Malaysia.

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1 Introduction

The increasing reliance on the private vehicles has caused the modal split for public transport to steadily decline since 1990 in Kuala Lumpur; in 1990 it was 40% and in 2000 it was down to 16% and remains almost at the same level in 2010 (Kuala Lumpur Structure Plan, 2000). Many improvements to the public transportation system in Kuala Lumpur were made in the last decade in order to address the burgeoning issue of traffic congestion; one such measure was the implementation of the Kelana Jaya LRT line. The first phase of Kelana Jaya LRT line was commenced on September 1, 1998 from Subang Depot to Pasar Seni station and second phase, from Pasar Seni station to Terminal Putra in June 1999. In 2002, the system carried its 150 millionth passenger, with an average of 160,000 passengers riding the system daily at that time. Today, it carries over 190,000 passengers a day and over 350,000 a day during national events. Moreover, an another rail-based transport system that was developed to overcome the traffic congestion is the Ekspress Rail Link (ERL) to KL International Airport which consists of two rail services namely KLIA Express and KLIA Transit. The KLIA transit provides more coverage as it makes three quick intermediate stops at key townships – Bandar Tasik Selatan, Putrajaya and Cyberjaya and Salak Tinggi before arriving at KL international airport. The KLIA Transit service integrates with KTM Commuter and RapidKL LRT at Bandar Tasik Selatan and Putrajaya (Putrajaya Sentral) and Cyberjaya station.

Kuala Lumpur is the most important city in Malaysia. It [1] is stated that Kuala Lumpur continues to be flooded with newly-registered motor vehicles each year. The number of vehicles has increased from 115,661 vehicles in 2000 to 208,560 in 2010 with an annual average growth rate of 4.45%. With the increase in the country's overall average income level, the demand for private vehicle ownership also increases. Besides, the affordable prices of locally-manufactured cars also encourage high demand for private vehicle ownership.

The construction of highways and ring roads in and around the city has improved the traffic flow, but to some extent, the city centre suffers both morning and evening traffic congestion, because of the increase in automobiles dependency especially in the metropolitan area. The increase in traffic congestion in the urban areas is also attributed by the low vehicle occupancy with an average of 1.10 people per vehicle. With the improvements in transport infrastructure connecting the suburbs and the city together with cheaper housing at the outskirts of the city, there exists a mismatch between residential and employment concentration at the city areas (Hamid [2]). Furthermore, the over-utilization of the roads and highways as well as the limited capacity of these infrastructures in accommodating the increase in the traffic volume, the issue of accessibility to the city centre has become one of the main agenda of the urban planners (Hamid [2]). It is also agreed by most authorities that congestion is going to get worse, as the capacity of the network will never increase in tandem with the increase in demand (Banister [3]). Even if it is possible to invest in expanding the infrastructure, this is not seen to be desirable for financial and environmental reasons (Banister [3]). Additionally the high number of private

vehicles in urban areas has led to congestion and pollution. In order to address these issues, Lam *et al.* [4] has indicated that the implementation of the park and ride schemes can be viewed as part of the answers towards reducing congestion in the urban areas.

The purpose of this paper is to investigate the utilization pattern of parking spaces at the Kelana Jaya, Terminal Putra and Putrajaya park and ride public transportation terminals. The adequacy of parking spaces to cater for the park and ride users is another important aspect which is being covered in this paper. The parking utilization characteristics such as parking accumulation, parking turnover, parking duration and parking occupancy were analysed at all three park and ride facilities. These stations were chosen because of their locations which cover a wider population catchment comprising mainly various types of residential areas expected to propel users to use LRT and KLIA transit services.

2 Literature review

Undoubtedly, parking is a basic need for transportation. It allows vehicles to stop and rest at the end of the journey. As the number of vehicles increases, the need for parking facilities also increases. It is crucial to minimize traffic congestions, accidents, pollution and unwanted fuel use through effective parking management and policies (Almselati *et al.* [5]). Park and ride is a scheme where the provision of parking spaces are allocated at a site, with some distance and access to public transport to reach users' desired destination (Ashley [6]); a large off-site parking space with a shuttle-bus serving the workplace (Hole [7]). With efficient planning of service networks that attracts riders who may not have otherwise used transit, park and ride is considered as an ideal element of urban mass transportation systems (Barnum *et al.* [8]).

Simpson [9] highlighted that the park and ride scheme has two main purposes which are first, to shift the modal split towards public transport and second, to reduce the needs for parking spaces in town centres. Park and ride scheme will grant an access to the town centres with relatively little environmental damages from traffic. Furthermore, Hole [7] also mentioned that park and ride scheme is particularly effective in reducing car use if the workplace has limited parking space on-site.

The ability of park and ride to reduce car use has been debated since mid 1990s (Meek *et al.* [10]). Parkhurst [11] has started to identify the implications of park and ride among Oxford and York users. He found that generated trips will increase mileage. Thus, trips to park and ride were considered as contributors to the increasing of car use.

Later, Parkhurst [12] argued that park and ride could induce a net increase rather than achieving reduction in traffic. He highlighted that high frequency and low load were the factors that park and ride buses caused in a net increase in the distance travelled in car equilibrium terms. Thus, Topp [13] and Parkhurst [14] proposed and developed the concept of 'Link and Ride' where it decentralized the park and ride sites. The sites are spread along a corridor, away from the city center but still could directly link to the satellite settlements. This concept has

proven to efficiently increase distance of bus journey, at the same time reduce car access trips in UK (Meek *et al.* [10]).

Additionally, Liu *et al.* [15] mentioned that the attractiveness and effectiveness of park and ride schemes depend mainly on its locations and parking charges, service quality and fares of public transits, level of road congestion, road tolls and parking charges at the city centres. The location of park and ride particularly in close proximity to residential areas, may serve users to use variety of modes (automobiles, motorcycles, bicycles, walking) as they transfer to transit or carpools (Aragon [16]). Parkhurst and Richardson [17] narrated that the general model of UK park and ride were located about 2–6 km radial routes from the urban core. Meek *et al.* [10] discusses that the sites for park and ride should be designed to attract the motorist with pleasant surroundings and on-site facilities such as waiting areas. He further explained that the sites must be integrated with other transport modes; with high quality buses operate at high frequency, generally between 8 and 15 minutes during peak periods and only one or two stops are usually made to minimize journey time.

A study methodology used by Snyder [18] regarding the study on parking supply and utilization in urban and suburban communities around the Puget Sound area of Washington State was referred. The parking utilization at six neighbourhood commercial centers in this study found that the average utilization rate ranged between 40% and 67%. It makes the percentage of parking spaces used below its full capacity. Parking supply exceeding demand, indeed, resulted in one site showing utilization rates far below the Urban Land Institute's recommendations for regional shopping centers. Furthermore, the dissimilarities between on-street and off-street utilization rates in the urban sites tend to depend, in part, on the relative convenience of the on-street parking.

Further, a study methodology by Hamid [2], stated that the trend in parking utilization was undertaken to analyze the demand and supply of the rail based park and ride facility of two commuter stations located at the fringe of the KL conurbation namely Shah Alam and Seremban station. This study found that both stations showed a relatively good level of utilization, exceeding the 80% mark but less than 95%. In terms of parking utilization, both stations shows similarity as the majority of the users were long term parkers (more than 8 hours). These users were mainly parked at these stations to travel to their workplaces. However, the demand for long term parking at Seremban station was higher than Shah Alam station. It, indeed, shows that the demand for the park and ride facility applies even for a relatively small conurbation. Furthermore, the high percentage of long term parkers indicates high demand to use the facility, particularly, among the work trip makers.

A study conducted at 49 Caltrans owned park and ride facility in San Francisco Bay Area at California by Shirgaokar and Deakin [19], found that 19 lots were at or approaching capacity that is 80% or more full, 13 lots at or over capacity where all spaces taken up and cars were parked on shoulders, 11 lots were heavily used and another 19 lots were underused where they had less than 50% occupancy at midday. The findings showed that the most of the lots were underused because they are located away from the freeway and several blocks

off the mainline transit route. Some of the lots were in isolated locations with no active land uses near the parking lots. Some other common problems identified at most of the lots were lack of security patrols, and some showed clear signs of vandalism, no sidewalk access, lack of bus shelters and signage on transit and ridesharing services were minimal.

3 Description of study area

Kelana Jaya LRT line is a medium capacity rail transport system and one of the three rail transit lines in the Kuala Lumpur rail transit system operated by RapidKL rail network. The other rail transit lines are the Ampang line and monorail line. The Kelana Jaya LRT line is aligned along the north-south direction, and passes through city centre of Kuala Lumpur with "Terminal Putra" and "Kelana Jaya" station as the terminal stations of this line. These two terminal stations cover a wider population catchment living in various types of residential areas. Thus, these two stations attract high number of park and ride users.

Terminal Putra acts as the north terminal station along Kelana Jaya LRT line**.** This facility is currently managed by Operasi Jitu Sdn. Bhd with a total of 538 parking spaces. Furthermore, this station also act as a bus transport hub for two of RapidKL's local shuttle bus routes, otherwise known as the 'Tempatan' route, and 'Genting Skyway' buses ferrying travelers to the Genting Skyway station in Genting Highlands recreational area.

On 15 February 2013, the Terminal Putra LRT station has started operating a new park and ride facility; a six level multi-storey parking which could accommodate 1260 vehicles at one time with special parking provision at the ground level for ladies and physically impaired persons. This new parking development project was started in June 2010 and completed in February 2013. The parking data used in this paper, however, was collected in 2009 before the construction of the new parking development project in 2010.

The Kelana Jaya station is located at the west terminal station along the Kelana Jaya LRT line**.** Kelana Jaya LRT station is also a rapidKL bus hub and it is accessible by other rapidKL bus routes connecting Damansara, Subang Jaya and Petaling Jaya areas. This park and ride station has two parking zones (Zone A and Zone B) with a total 529 parking bays. This park and ride facility was opened on September 1, 1998; the same day in which Kelana Jaya LRT Line service commences. These two park and ride facilities charge users a flat parking rate of RM 3.00 per entry (US$1.00) for LRT users. The parking fee can also be paid by using *"Touch 'n Go system",* a smartcard payment method.

The KLIA Transit connects Kuala Lumpur International Airport (KLIA) with the city centre of Kuala Lumpur. Among the stations connected by KLIA Transit are KL Sentral, Bandar Tasik Selatan, Putrajaya and Cyberjaya, Salak Tinggi and KLIA. One of the stations of this line provides park and ride facility at Putrajaya and Cyberjaya station which is normally known as Putrajaya Sentral. Putrajaya Sentral provides multimodal transport services namely KLIA Transit, intercity and intracity buses, express bus and taxi services. The provision of the park and ride facility at this station can help to increase the ridership of the

public transportation as this station is located within a huge residential catchment area. This station provides two types of parking facility namely multi-storey parking and surface parking with a total of 1522 parking spaces.

4 Objectives and methodology

The following are the objectives of this study;

1) To analyze the provision of existing parking supply and its associated physical elements.
2) To evaluate parking utilization pattern of the users for the purpose of determining parking demand at park and ride stations.

Two methods were applied for data collection; parking inventory and parking utilization surveys.

Parking space inventory survey involves inventory of existing parking facilities and its physical conditions such as location, number of parking spaces, internal circulation system (Roess *et al.* [20]). The *parking space utilization survey* involves determining the extent of parking usage (includes counting of parked vehicles at regular intervals over a period of time) over a pre-determined time period. The beat survey method was used where the data on parking demand was obtained by recording the registration plate number of the vehicles parked in each parking space for a period of 13 hours from 7:00 am to 8:00 pm with an interval period of 30 minutes. The data on parking demand is important in understanding the parking behavior (Slinn *et al.* [21]) of the parking users. This method was applied to collect data pertaining only to vehicle arrival at the parking areas.

Parking accumulation refers to the number of vehicles parked at a given time (Roess *et al.* [20]). Data was analyzed by calculating the total number of cars parked in the parking lot at every 30 minutes interval. The findings, then, were presented in a line-chart form to display the fluctuations in parking accumulation throughout the study period.

Parking occupancy is the percentage of occupied parking spaces during a specific period of time. It relates parking demand with the existing parking supply. Furthermore, the parking occupancy also indicates the peak-hour demand (Hamsa [22]). The parking occupancy was analyzed by calculating the number of available parking that actually used in the facility. The findings were presented in a histogram form to show the occupancy rates at the parking lots.

Parking duration is the length of time a vehicle parked at a space (Hobbs and Richardson [23]). The average parking duration also helps to identify whether a parking facility is used as a short-term or long-term (Hamsa [22]). Duration is calculated by dividing the total vehicle-minutes parked (time period of vehicles occupying parking spaces at the facility) by the total number of vehicles parked.

Parking turnover is the number of vehicles utilizing the same parking space over a given period of time. In short, it is known as the rate of usage of parking space (Ashley [6], Hobbs and Richardson [23]). The parking turnover for individual parking spaces was determined by counting the number of different cars using a particular parking space throughout the 13-hour study period. It

determines the utilization rate of individual parking spaces (Hamsa [22]). The average parking turnover for the parking lots is computed by dividing the total number of cars parked throughout the study period with the total number of parking spaces.

5 Analysis of existing parking usage at park and ride facility

5.1 Existing parking supply

Terminal Putra park and ride facility provides a total of 538 parking spaces for cars. This parking facility is segregated into 3 lots, which are Lot A (100 parking spaces), Lot B (97 parking spaces) and Lot C (341 parking spaces) (Figure 1).

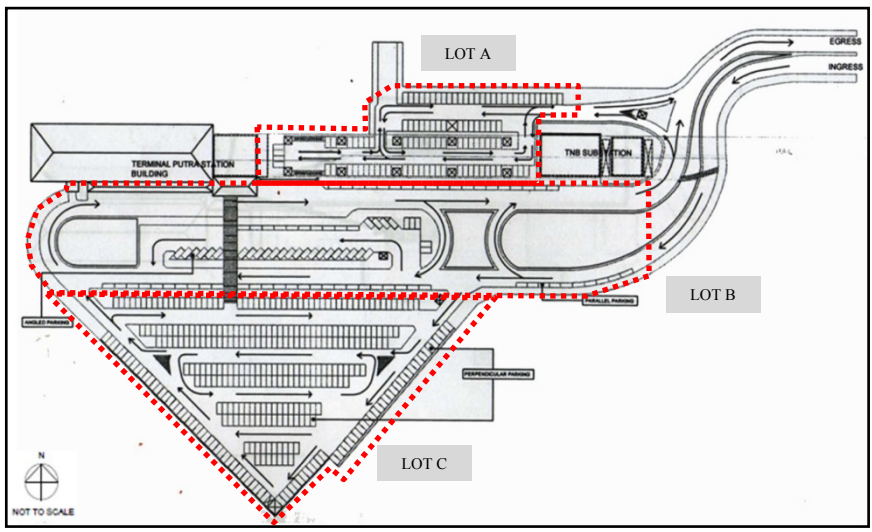

Figure 1: Parking provision at Terminal Putra LRT station.

Whereas park and ride facility at Kelana Jaya station provides a total of 529 parking spaces for cars (Figure 2). The parking area is segregated into two zones, which are Zone A (287 parking spaces) and Zone B (241 parking spaces).

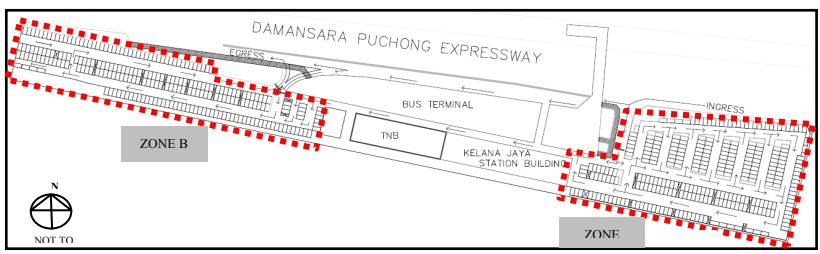

Figure 2: Parking provision at Kelana Jaya LRT station.

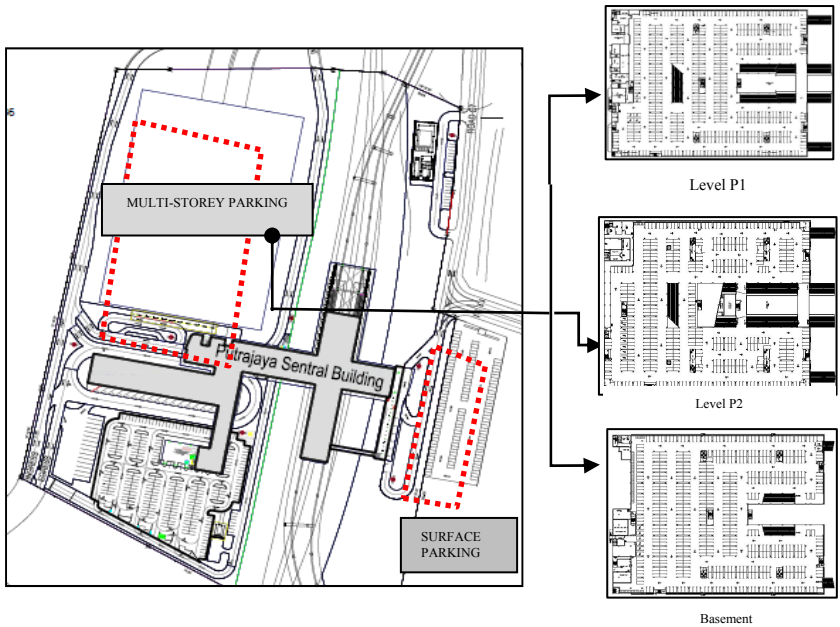

Figure 3: Parking provision at Putrajaya Sentral.

Putrajaya Sentral park and ride facility consists of three parking areas. However, only two areas were selected for this study which are multi-storey parking that comprises of three levels of parking (level P1 = 476 parking spaces, level P2 = 411 parking spaces, and basement = 514 parking spaces) and one surface parking lot (Figure 3). The total number of parking spaces in multi-storey parking is 1401 of which 20 parking spaces were reserved for the disabled users and the surface parking 121 parking spaces with no reserved parking spaces.

The internal circulation for the vehicles at Terminal Putra park and ride facility was both one-way and two-way movements, Kelana Jaya and Putrajaya Sentral one-way circulation system.

5.2 Existing parking usage

The parking usage at park and ride facilities was measured by parking accumulation, occupancy, turnover and duration. A 13-hour parking usage survey at all park and ride facilities shows almost similar parking usage pattern. The parking accumulation curve at three lots at Terminal Putra station shows a steep rise in the number of cars parked between 7.00 am to 9.00 am due to continuous arrival of users taking LRT for work purposes (Figure 4). This trend was found similar to the 142 parking spaces at Shah Alam park and ride facility where a high number of in and out-vehicle flow from 5.30 am to 6.30 am on a weekday was observed (Hamid [2]). The parking demand at Terminal Putra

station from 9.00 am to 4.30 pm was high and remains fairly constant. The accumulation curve then started to gradually decrease from 4.30 pm onwards as users were found leaving the parking spaces indicating travel to home from their workplaces. This scenario reflects the regular weekday morning and evening rush hour for commuters and were being consistent with the trip patterns of those on compulsory trips namely to work and school/college (Hamid [2]).

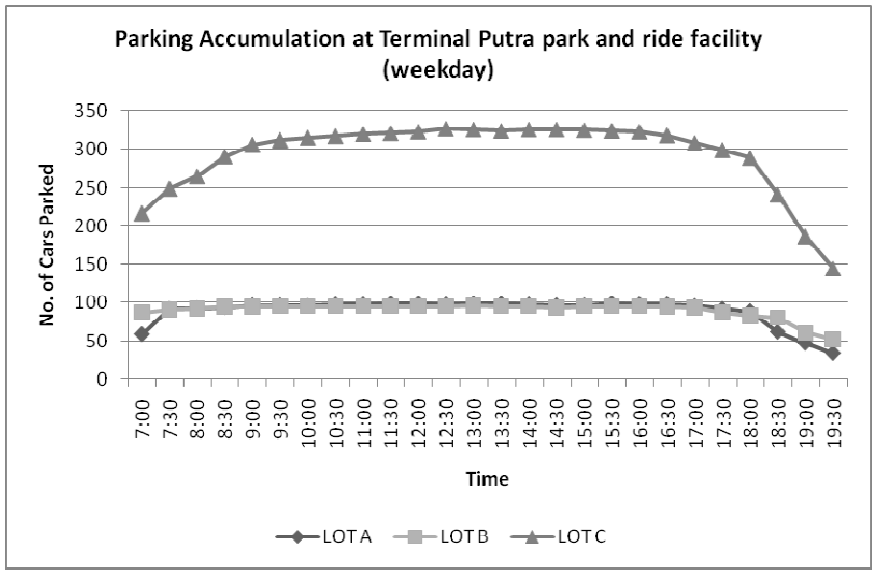

Figure 4: Parking accumulations at Terminal Putra park and ride facility.

The Kelana Jaya park and ride facility provides 529 parking spaces, slightly less than Terminal Putra station. The parking accumulation curve at this station shows almost similar pattern to that of Terminal Putra station (Figure 5) reaching maximum capacity in the early morning rush hours. However, the arrival of vehicles at Terminal Putra station was progressive before reaching its peak capacity at 10 a.m. Whereas, the number of vehicles parked at the Kelana Jaya station was found reaching its capacity as early as 7.00 a.m. and remain constantly at high level until 3.30 p.m. This is due to the intense concentration of residential areas near the Kelana Jaya station as compared to Terminal Putra station. This pattern of early morning peak accumulation was also seen in Hong Kong park and ride facility where it reaches the highest demand during morning peak period between 7:00 am and 9:00 am (Lam *et al.* [4]).

Similarly, the accumulation curve at the Putrajaya Sentral park and ride facility showed an increase in the number of vehicles arrival as early as 7.00 am at all parking lots (Figure 6). It continues to increase further until 9.00 am and it remains almost constant until 5.30 pm. This pattern is again comparable with that of Terminal Putra and Kelana Jaya stations, where the majority of the users

who parked at these facilities were traveled for work purpose by public transport. The number of vehicles parked at each level of the multi-storey parking facility was different; level 2 has reached the highest number of vehicles parked, 233 vehicles from 2.00 pm to 3.00 pm. The findings showed that the most of the vehicles were preferred to park at this level because of its proximity to station building located at level 3 of the building.

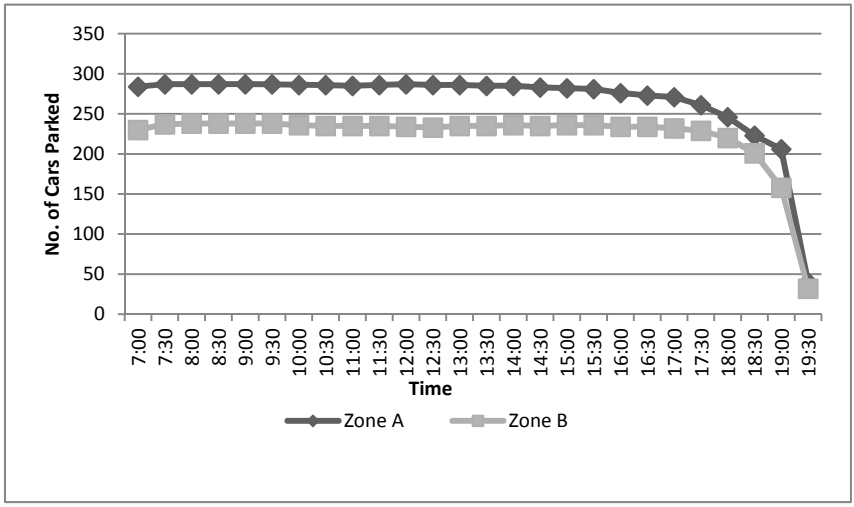

Figure 5: Parking accumulations at Kelana Jaya park and ride facility.

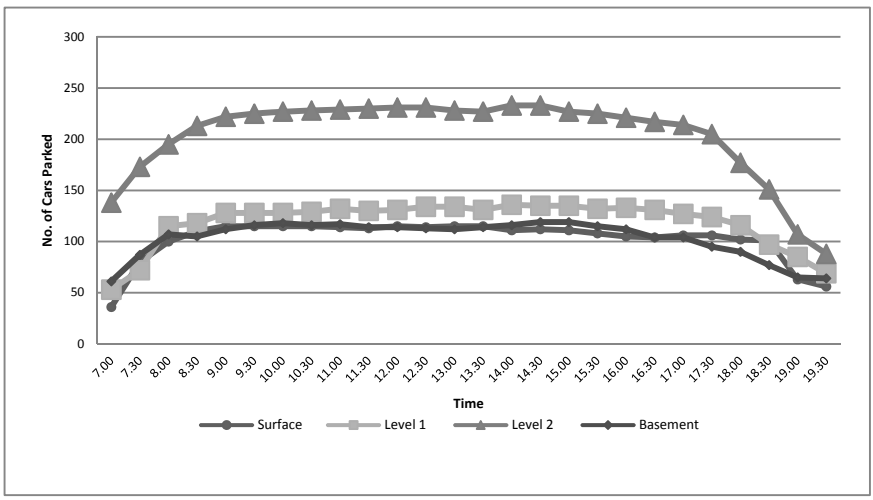

Figure 6: Parking accumulations at Putrajaya Sentral park and ride facility.

The analysis on *parking occupancy* showed that more than 80% of parking spaces at Terminal Putra park and ride facility were occupied. Figure 7 shows Lot B was the most preferred parking area at Terminal Putra station with occupancy of 94%. Despite, Lot A was located near to the station in terms of distance, however, Lot B which was located directly in front of the station's entrance has made it strategic and preferable. The parking occupancy at Lot B of the Terminal Putra station has reached more than 90% as early as 7 in the morning. On the other hand, Lot A and Lot C has taken longer time to reach 90% occupancy rate. It clearly shows that the parking location in front of the railway station is normally more attractive and preferable as it provides users easy and direct access to the station building.

The average parking occupancy at Kelana Jaya park and ride facility was similar to that of Terminal Putra station (Figure 7) where it also reaches more than 90%. The analysis further shows that parking occupancy at Zone A has reached 100% between 7:30 am and 9:00 am. The parking load was maintained at high level (over 90%) during day time which obviously reflects that the majority of those who parked at this area were travelled for work purpose. Moreover, Zone A parking area is located nearer to the station building than Zone B which creates higher parking demand.

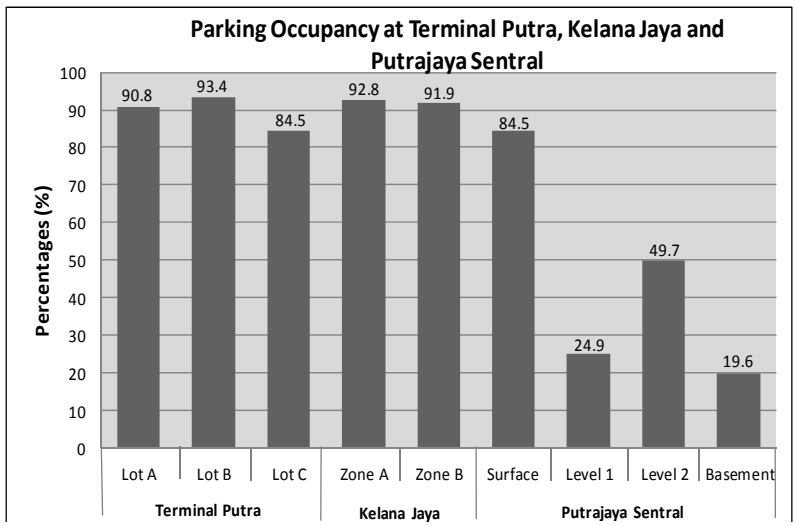

Figure 7: Parking occupancy at Terminal Putra, Kelana Jaya and Putrajaya Sentral park and ride facility.

The average parking occupancy at Putrajaya Sentral park and ride facility was lower than Terminal Putra and Kelana Jaya stations. Among all the parking lots in Putrajaya Sentral, surface parking area has the highest occupancy rate (85%). The parking demand at this parking area was high because of its nearness to

the terminal building which allows users to walk for a short distance to reach the terminal building from this parking area. On the other hand, the multi-storey parking at this station showed high occupancy rate only at level 2 (about 50%) but low demand at level 1 and basement (below 30%). The parking occupancy at level 2 was higher than other levels because it is located near to the transit station (one level above at level 3). It was also found at all levels, the vehicles were parked near to the staircase and lift that linked to the entrance of the terminal building. The findings highlight that the distance, conveniences, direct access to reach the terminal building from the parking areas were the important determinant factors for high utilization rate of the parking facility. The findings also show the average parking occupancy at the surface parking area was higher than the multi-storey parking despite the number of parking spaces in multi-storey parking facility was much higher than surface parking. Again, it clearly shows that the surface parking facility was more attractive to the park and ride users than multi-storey parking because of the easiness and conveniences to park at the surface parking than multi-storey parking.

The analysis on *parking turnover* showed a low parking turnover at each station, not more than 2 vehicles per space. The low turnover rate means less vehicle movement at individual parking space. It also indicates that the vehicles were parked for long duration. The highest turnover was in Lot B (1.5 vehicles per space) at Terminal Putra station. The fiindings show that once the parking spaces were emptied in the evening hours, they were taken up by the people who park at these spaces (for a very short period) to pick up their family members, relatives and friends at this station.

The parking turnover at the multi-storey parking in Putrajaya Sentral was lower than surface parking. It is because of the low parking demand and also due to the attractiveness of the surface parking in terms of its location and accessibility. Besides, more short term parkers were preferred to park at the surface parking due to easiness and convenience, thus contributing to high parking turnover.

The *average parking duration* of the vehicles at all three park and ride facilities shows long-term parking, considering vehicles parked more than 3 hours as long-term parking (Hamsa [22]). On average, vehicles were parked more than 7 hours at each of the three parking lots at Terminal Putra station. The majority of the users, especially during weekday, who parked their vehicles at this station, were found to travel for work purposes by using public transport.

The average parking duration at Kelana Jaya park and ride facility was the highest among all park and ride facility, averaging more than 11 hours at both zones. The high concentration of residential areas near to this station is obviously the likely reason for this trend. Whereas the average parking duration at Putrajaya Sentral park and ride facility was more than 9 hours. These results indicate that the vehicles were predominantly parked for long hours. The long-term parking at this facility was identical with that of Shah Alam and Seremban park and ride facility. About 56% of parkers at Shah Alam station were parked for more than 8 hours whereas at Seremban park and ride facility, about 82% of total parkers were long term parkers (Hamid [2]). The spatial factor of the

stations and the travel pattern of the users are the likely causes for this trend. The findings show that the location of park and ride facility near to the high concentration of residential areas is a very important deciding factor for its optimum utilization to encourage users to shift from private to public transport.

6 Conclusions

Park and ride schemes at public transportation terminals and stations at the outskirts and at the periphery of the urban areas is one of the viable measures to alleviate the increase in the number of private cars entering into the city areas. However, the provision of adequate number of parking spaces, type of parking and the location of parking areas at a park and ride facility is very important and crucial for the success of the facility.

The parking demand pattern at the selected park and ride facilities shows that most of the parkers, who parked their vehicles at these facilities especially during weekday, were traveling for work purposes. The parking data shows a high parking demand at both Terminal Putra and Kelana Jaya park and ride facility. Whereas in Putrajaya Sentral, the parking demand at surface parking area was high but low at multi-storey parking. The parking accumulation curve showed that parking spaces were fully occupied as early as 7 a.m. and remains fully occupied until 4.30 p.m. Thus, it eventually leads vehicles to park at undesignated locations near to the station. The location of the parking area facing the terminal station was the most preferable choice to the parkers due to its nearness, easiness, conveniences and direct access to the station building. In the case of Putrajaya Sentral park and ride facility where both surface and multi-storey parking were provided, the users' choice to park at surface parking areas was much higher than multi-storey parking. Vehicles were usually parked for long duration (more than 7 hours, on average) at all stations as most of the users who parked their vehicles were traveled for work purposes.

The high parking demand at these facilities especially at Terminal Putra and Kelana Jaya stations warranted the necessity to expand the parking areas to accommodate more parking users. However, due to unavailability of land to expand it horizontally at these facilities, a multi-storey parking facility should be considered to increase the number of parking spaces. In fact, a year after the completion of the survey at Terminal Putra LRT park and ride station, the construction of multi-storey parking at the surface parking area begun in 2010 and completed in the early 2013. Now, a multi-storey parking facility at the Terminal Putra LRT park and ride station with more number of parking spaces is operational. However, the low parking utilization at the existing multi-storey parking at Putrajaya Sentral has reminded to plan parking supply appropriately to optimize its use both for the existing and future parking demand. This scenario was due to the provision of surface parking areas in addition to multi-storey parking at this station.

Undoubtedly, park and ride facility helps to decrease the number of vehicles entering into the cities achieving the universal goal and benefits of sustainable

transportation. It is highly advisable, however, to ensure adequate parking supply with affordable parking fee to cater for parking demand at the park and ride facility.

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