Evaluating the Parking Demand at Park and Ride Facility at Putrajaya Public Transportation Terminal

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Abstract: The purpose of this paper is to analyze the level of parking utilization at two types of parking namely multi-storey and surface parking at Putrajaya public transportation terminal. A parking utilization survey was conducted to determine the parking demand of the users. The analysis of this paper focuses on parking characteristics such as parking accumulation, occupancy, duration, turnover, and volume. The parking demand on weekday was higher than weekend and surface parking shows higher demand than multi-storey parking both on weekend and weekday. The average parking occupancy at surface parking on weekday was 84.5% as compared to level 1 (25%), level 2 (50%) and basement (20%) of the multi-storey parking. The parking duration showed that the users were parked more than 9 hours as they were traveling for work purpose. A high parking demand at the park and ride facility will, eventually, help to achieve the benefits of sustainable transportation.

Keywords: Parking Demand, Parking Characteristics, Multi-storey Parking, Surface Parking

1. INTRODUCTION

The growth of motor vehicles has been contributing to various negative effects such as traffic congestion, increase in driver and passenger travel time and their associated costs. Besides, this situation also contributes to increase in fuel consumptions, air, noise pollution and accident and fatality rates. Prabuwono and Idris (2008) stated that an increase in car ownership, changes in traffic arrangements and densification of land has contributed to the diminishing supply of parking facility especially in the Centre Business District (CBD). Hence, promoting public transportation is a way to reduce the use of private cars in urban areas and thereby reducing the adverse impacts of transportation (Banister, 2000). One such strategy that is widely applied towards encouraging commuters to use public transport is the implementation of the park and ride scheme, which is seen as a Transportation Demand Management (TDM) strategy. Moreover, this scheme can become a solution to the traffic problems by replacing long car trips with a combination of car and public transport, consisting of one short car trip and one longer trip by public transport. Thus, it is possible to minimize the private car travel into the CBD areas as well as reducing the congestion during morning and evening peak hours (Borhan M.N *et al.*, 2011). It is well supported by Lam *et al.* (2001)

and Runkel (1993) studies which suggested that the implementation of the park and ride schemes has been viewed part of the answer towards reducing congestion in the urban areas particularly that of the city centre.

Therefore, the purpose of this paper is to examine the parking demand on weekday and weekend at the park and ride facilities at Putrajaya public transportation terminal. The main objectives of the study are:

  i To evaluate parking characteristics such as parking accumulation, parking occupancy, parking duration, parking turnover, and parking volume at the selected facility.

  ii To examine the existing parking demand at the parking facility given the different parking types and supply.

2. LITERATURE REVIEW

The park and ride concept involves commuters driving to the public transport terminals, parked their vehicles and continues their journey to their destination by public transport. Noel (1998) describes park and ride as an operation in which commuters, travel by private vehicle, either as drivers or as passengers, gathers at a common site that enables them to transfer to higher-occupancy vehicles. These higher-occupancy vehicles may be automobiles, vans, commuter trains or buses, or urban public transit. The provision of parking facilities at the public transportation terminal is important in order to increase the demand for public transportation ridership. Garber J. and Hoel A. (2002) identified that the growing use of automobile as a personal feeder service to transit systems has also increased the demand for parking spaces at transit stations. Besides, Kuby *et al.* (2004) had clearly highlighted the positive association of park and ride facility with the ridership of the light rail stations. It has established the fact that the park and ride facility does positively generate ridership for the Light Rail Transit (LRT) in low-density, car-oriented, polycentric US cities with smaller downtowns, for trips to the CBD.

In order to evaluate the effectiveness and importance of the facility, a study regarding the utilization of the park and ride facility is essential to identify the actual parking demand of selected park and ride facilities. Basically, parking demand can be explained from the analysis of parking characteristics such as parking accumulation, parking occupancy, parking duration, parking turnover, and parking volume. Kadar Hamsa (2005) provides the definition on the parking characteristics. Parking accumulation is the total number of vehicles parked in a specific area (usually segregated by type of parking facility) at a specific time. Parking occupancy is represented by the percentage of occupied parking spaces during a specific period of time. Then, parking duration is the length of time a vehicle remains in one parking space. Normally, parking duration is divided into short-term parking, mid-term parking and long term parking (Edwards, 1992). While, parking turnover is described as the number of different vehicles parked at a specific parking space or facility during the study period, and this is to measure the utilization of particular parking space. Next, Hobbs and Richardson (1967) and Ashley (1994) defines the parking volume as the total number of vehicles parked in a study area during specific period of time.

Several previous studies regarding the utilization pattern of the park and ride facilities were reviewed. Abdul Hamid N. (2009) studied the daily weekday parking demand at the park and ride facility located at the suburbs of Shah Alam and Seremban railway stations. The findings on parking demand was attained based on the analysis of the parking utilization indices namely its utilization (occupancy rate), accumulation as well as the duration of the

facility itself. The results of this study revealed that the overall utilization rate at Shah Alam railway station was 95.1% while Seremban was 97.5%. This situation showed that these two park and ride facilities were highly occupied which reflects high demand from the rail transit users during weekdays. It is mainly due to the high demand for work trip purposes. In term of the parking duration, majority of the parking users at Shah Alam station (55.6%) were parked for more than 8 hours. However, the results on parking duration at Seremban station is higher where 81.8% of the users parked for more than 8 hours while only 18.2% of the total users were parked less than 8 hours. The high percentage of long term parkers showed that there exists keen interest to utilize the park and ride facility particularly among the work trip makers of the suburban population (Abdul Hamid N., 2009). The high percentage of long term parkers indicates that there is demand for the park and ride facilities especially among the trip makers from suburban area. This is similar to the findings by Kwon (2001), where 52.8% of the users at the Seoul Metropolitan Area (SMA) were long term parkers who parked, on an average, for about 8 hours per day.

In addition, the study conducted at the park and ride facility in San Francisco Bay Area at California by Shirgaokar and Deakin (2005), found that from the surveys conducted at 49 Caltrans owned park and ride lots in the region, 19 lots were at or approaching capacity that is 80% or more full, 13 lots at or over capacity where all spaces taken and cars parked on shoulders. Moreover, 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 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 nearby. Some other common problems identified at most of the lots were lack of security patrols, and some showed clear sign of vandalism, no sidewalk access, lack of bus shelters and signage on transit and ridesharing services were minimal. Besides the occupancy survey, the parking users' survey results revealed that almost all commuters who worked full-time were using the same park and ride lot for four or more days a week. Many park and ride users also were early travelers to ensure the availability of a parking space in the park and ride lots, but for many other workers, the early start was necessary due to the long distances that they need to travel.

Furthermore, Hamer (2010) has studied on the demand of upgraded park and ride facilities in Melbourne, Australia. This survey was conducted at seven sites which grouped into three travel zones namely inner metropolitan, outer metropolitan and regional. The result revealed that park and ride plays an important role in Melbourne's public transport system where total number of parked cars exceeded the number of parking spaces by approximately 50% with overflow parking can be found on local residential streets. Across all five metropolitan stations, car parking demand has increased by 21%, while public transport boarding increased by 13%. These results can be compared against the entire metropolitan rail network where, between 2006 and 2008,car parking use has increased by an average of 9% per annum, while boarding increased by an average of 10% per annum (Department of Transport, 2008a; Department of Transport, 2008b). In 2008, the first seven car parking upgrades were opened, with the provision of additional 580 car parking spaces for commuters. Nevertheless, the provision of an additional 580 car parking spaces at these locations was found inadequate, thus requiring a further addition of 382 car parking spaces. It clearly indicates a huge demand on the park and ride facilities as the travel demand by the public transport were increased.

3. DESCRIPTION OF THE SELECTED PARK AND RIDE FACILITY

Putrajaya is located 25km south of Kuala Lumpur and serves as the federal administrative centre of Malaysia. The selected park and ride facility is located at Precinct 7, Putrajaya. The park and ride facility is provided to serve public transportation users at Putrajaya public transportation terminal (Putrajaya Sentral) either to travel outside Putrajaya or within Putrajaya. The various modes of public transportation available at Putrajaya Sentral are Express Rail Link (ERL), intercity and intracity buses, express bus, as well as taxi services. Two types of parking facility were choosen for this study namely multi-storey parking and surface parking (figure 1-figure 3). The number of parking spaces provided at multi-storey parking and surface parking is shown in table 1.

Table 1. Parking supply at Putrajaya Sentral park and ride facility

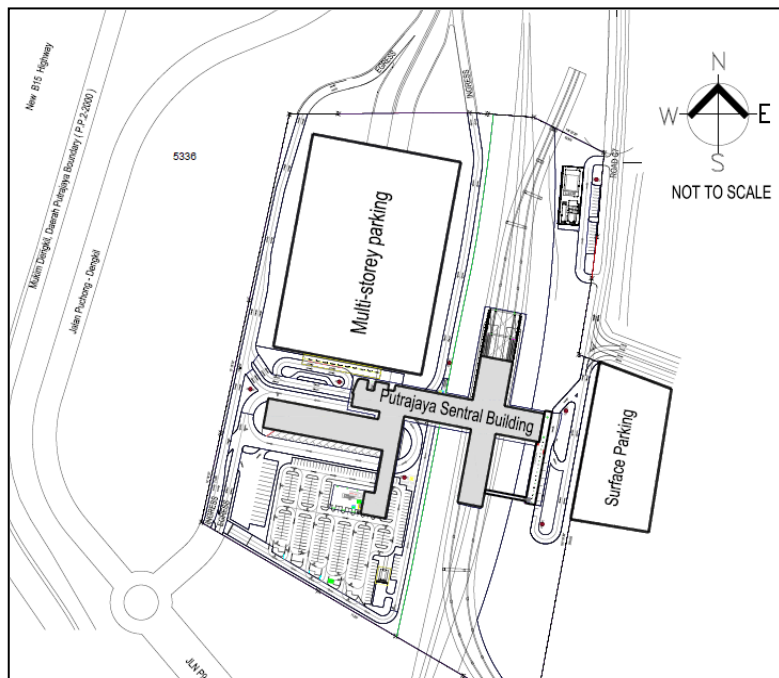| Types of Parking	Areas / Levels	Number of Parking Spaces
Multi-storey	1	476
	2	411
	Basement	514
	Total	**1401**
Surface		121
Total Parking Supply		**1522**

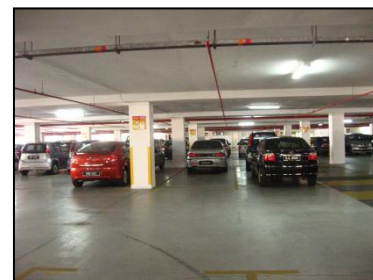Figure 1. Location of parking facilities at Putrajaya Sentral

Figure 2. Multi-storey parking

Figure 3. Surface parking

4. RESEARCH APPROACH

4.1 Data Collection

Parking utilization survey was carried out to collect data on parking characteristics. The

purpose of this survey is to gauge the present level of parking usage at the park and ride facility in terms of evaluating the parking characteristics such as parking accumulation, parking turnover, parking volume, parking duration and occupancy. The methodology employed in this study is based on the beat survey. The survey was administered by recording the last four digits of each vehicle's license plate number parked at each parking space at every 30 minutes interval. A two-day parking utilization survey was administered, one day on weekend (Sunday) and the other on weekday (Tuesday) in January 2013. This survey was conducted for thirteen hours starting from 7.00 am to 8.00 pm on each selected day.

The second type of survey involved in this study is questionnaire survey. The purpose of this survey is to identify the information regarding the park and ride users' perceptions on several characteristics such as socioeconomic, travel and parking related characteristics. The methods used to distribute the questionnaires were face-to-face interviews with the park and ride users and dropping the questionnaire at the parking counters for the park and ride users to complete it and collecting it at the counter at a later date.

4.2 Method of Data Analysis

The analysis of the collected data was undertaken to estimate the parking characteristics at the selected park and ride facility. The following are the methods used to calculate each of the parking characteristics:

$$\textbf{Parking Occupancy} = \frac{\text{Vehicle Accumulation}}{\text{Total number of Parking Spaces}} \text{ X } 100$$

$$\textbf{Parking Duration} = \frac{\text{Total Vehicles - Minutes of Parked Vehicles}}{\text{Total number of Vehicles Parked}}$$

$$\textbf{Average hourly Parking Volume} = \frac{\text{Total Accumulation of Vehicles}}{\text{Total Survey Period (in hours)}}$$

$$\textbf{Average Parking Turnover} = \frac{\text{Total number of Vehicles Parked}}{\text{Total number of Parking Spaces}}$$

5. ANALYSIS ON PARKING CHARACTERISTICS

5.1 Parking Accumulation

The accumulation curve at the surface parking facility on weekday showed an increase in the number of vehicles arrival as early as 7.00 am and it continues to increase further until 9.00 am (figure 4). Then, this parking area achieves its highest capacity of 115 vehicles at 9.00 am and it remains almost constant until 6.30 pm. This trend was found compatible with the users' arrival time from the questionnaire survey indicating the usual pattern of a working day where

people travel to workplace as early as in the morning and return home after the working hours in the evening. Abdul Hamid N. (2009) has stated that this scenario reflects the regular weekday morning and evening rush hour for users which is consistent with the trip patterns of those on compulsory trips namely to work and education. The parking accumulation on weekend showed a steady growth in the number of vehicles arrival reaching a maximum number of 66 vehicles from 12.00 noon to 2.30 pm. It is probably due to the various non-compulsory trips being performed by the users such as recreational, shopping, and tourism activities. Thus, these types of trip were found to have variations in the arrival and departure time of the parking users. However, at the end of the survey time on weekend, it was observed that the number of vehicles parked decreased from 56 vehicles to 40 vehicles.
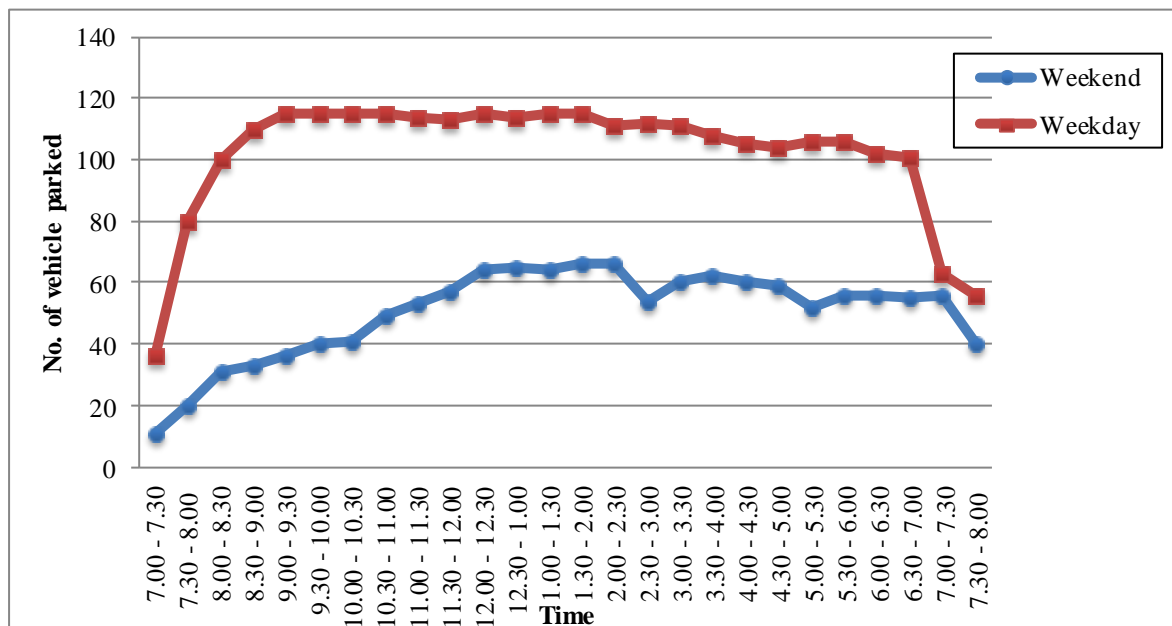

Figure 4. Parking accumulation pattern of surface parking

On the other hand, the weekday parking accumulation pattern at all three levels of multi-storey parking showed a similar accumulation pattern to that of surface parking where the accumulation curve increases between 7.00 am and 10.00 am and sharply decreases after 5.00 pm. (figure 5-figure 7). It is because that the majority of the users were parked at this facility and traveled by public transport for work purpose. The findings from the questionnaire data showed that 100% of the users that utilized this facility "every weekday" were traveled for working purpose. This trend was relatively similar to that of Hong Kong experience where its average flow entering to one of its trial scheme' park and ride facility on critical days was found to be greatest during the morning peak period between 7.00 am and 9.00 am (Lam *et al.* 2001). However, the number of vehicles parked at each level of the multi-storey parking facility was different; level 2 has achieved the highest number of vehicles parked, 233 vehicles from 2.00 pm to 3.00 pm. More vehicles were preferred to park at this level because of proximity to reach public transport terminal located at level 3 of the building. Level 1 was found to have a maximum of 136 vehicles parked at 2.00 pm and basement level, a maximum of 119 vehicles at 3.00 pm. However, the parking accumulation curve at all the levels has started to steeply decrease from 5.00 pm to 8.00 pm as the users were returning from their work places.
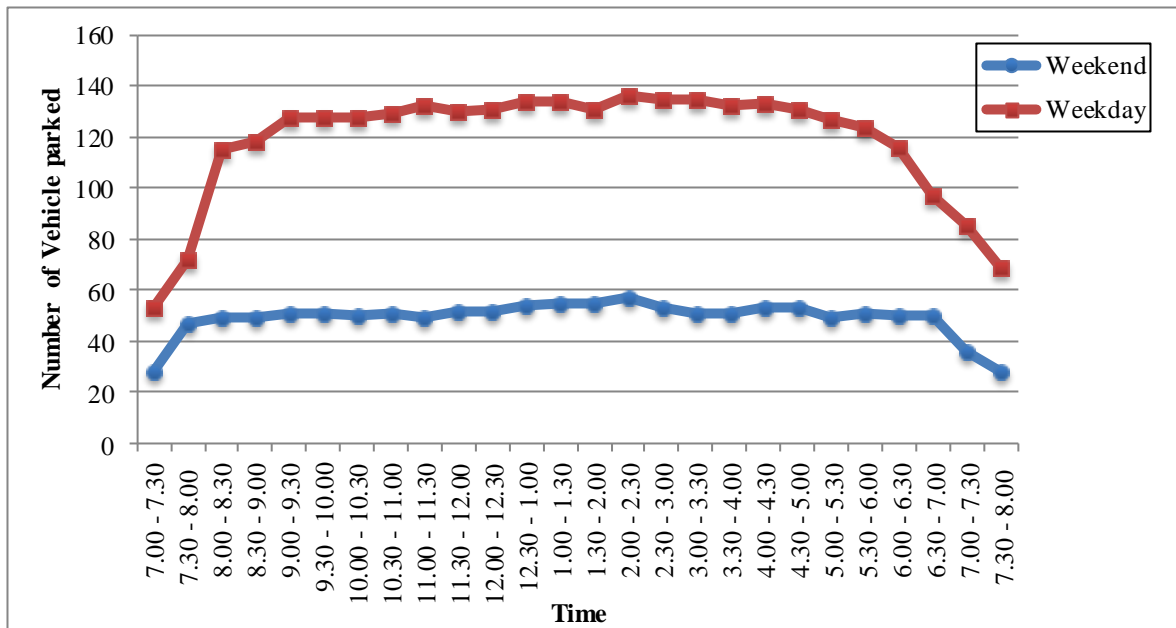
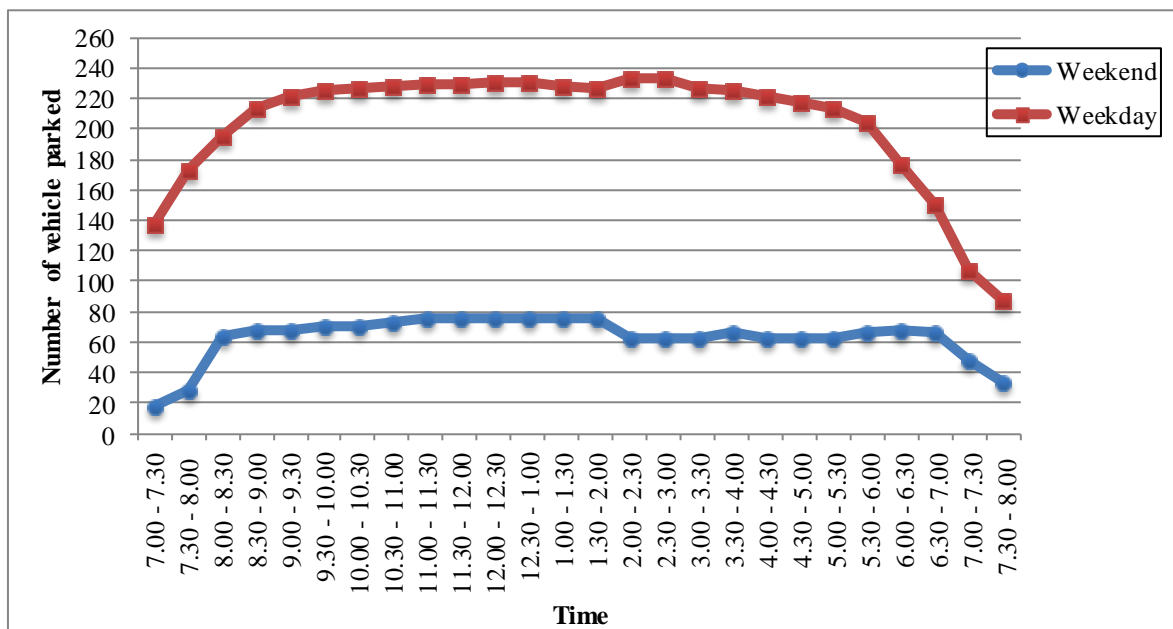Figure 5. Parking accumulation pattern of multi-story parking at level 1

Figure 6. Parking accumulation pattern of multi-story parking at level 2

Furthermore, the parking accumulation pattern on weekend at all levels in the multi-storey parking were slightly similar to that of weekday pattern where the accumulation curve has started to rise from 7.00 am to 8.30 am but remained lower than weekday throughout the day. During the survey, it was found that the park and ride facility at Putrajaya Sentral was opened for the overnight parking users, so there is possibility that some vehicles which occupied the parking facility at the beginning of the survey period were obviously overnight parking users. In terms of the number of vehicles parked at each level, the maximum number was 76 vehicles at level 2, 72 vehicles at basement level and 57 vehicles at level 1. The

parking demand was generally very low on weekend as some trip purposes such as social and recreation, most of the users would probably prefer to travel by private vehicles instead of public transport due to factors such as convenience and flexible travel time.
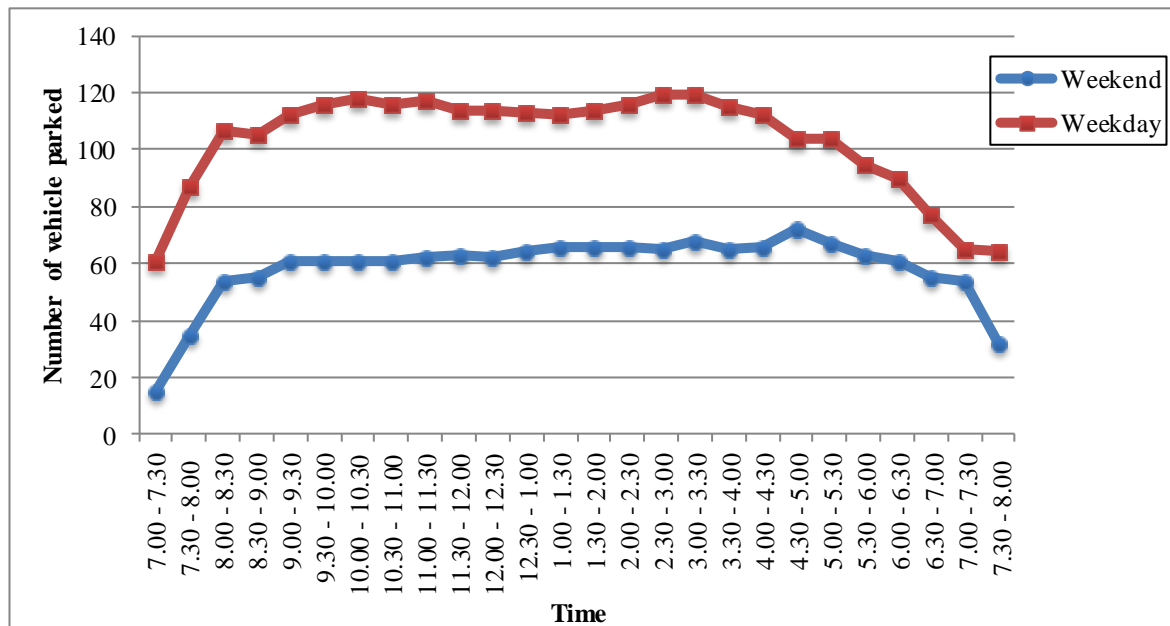

Figure 7. Parking accumulation pattern of multi-storey parking at basement level

5.2 Parking Occupancy

The average parking occupancy rate during weekday at surface parking was 84.5% (table 4) and achieved the maximum occupancy rate of 95% at 9.00 am. It was observed that few car parking spaces were occupied by motorcycles. The observation also showed that few cars were parked as double-parking in the surface parking facility during the survey period indicating a high parking demand. The parking demand at this parking facility was high because of its nearness to the terminal building and to the Express Rail Link (ERL) thereby reducing walking distance of the users from this parking facility to the public transportation terminal. On the other hand, the average parking occupancy at the multi-storey parking facility was below 30% at level 1 and basement level indicating a low parking demand. Nevertheless, the average parking occupancy at level 2 was 50%. Therefore, 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). Generally, the average parking occupancy at the surface parking facility on weekday was higher than the multi-storey parking facility. But, the number of parking spaces in multi-storey parking facility was much higher than surface parking. It clearly showed that the surface parking facility was more attractive to the park and ride users than multi-storey parking. One of the obvious reasons for this trend could be the easiness to park at the surface parking than multi-storey parking.

The average parking occupancy rate at surface parking on weekend was 41.7%, reaching a maximum occupancy rate of 54% between 1.30 pm and 2.30pm. On the other hand, the average parking occupancy at all the levels in multi-storey parking was less than 20%. Among all the levels in multi-storey parking, level 2 again has recorded the highest average parking occupancy rate (15%), reaching a maximum occupancy of 18.5% from 12.30

pm to 2.00 pm. The findings showed that the parking occupancy rate on weekend was lower than weekday. One of the obvious reasons for this trend could be high number of social and recreational trips were made during weeend which necessitate the users to use private transport.

5.3 Parking Duration

Parking duration is classified into short-term, mid-term and long-term. According to (Abdul Hamid N., 2009), short-term parking is defined as those parking duration of less than 5 hours while mid-term parking refers to the parking duration of 5 to 8 hours and those exceeding 8 hours are consider long-term parking. The average parking duration at the surface parking during weekday was 9 hours 10 minutes (table 4). Throughout the survey period, about 94% of the vehicles were parked between 9 and 13 hours (table 2). The findings from the questionnaire survey data also showed about 62% of the surface parking users were parked for more than 9 hours. These results indicate that the parking duration at surface parking on weekdays was predominantly long-term parking.

Table 2. Duration of parking at Putrajaya Sentral

Parking Areas	Parking Duration (Hours)	Weekday		Weekend	
		No. of vehicles parked	Percentage (%)	No. of vehicles parked	Percentage (%)
Surface Parking	1 hour – 5 hours	0	0.0	13	17.1
	5 hours – 9 hours	7	6.1	19	25.0
	9 hours – 13 hours	108	93.9	44	57.9
	Total	**115**	**100.0**	**76**	**100.0**
Level 1	1 hour – 5 hours	5	3.55	15	23.1
	5 hours – 9 hours	13	9.22	7	10.8
	9 hours – 13 hours	123	87.23	43	66.1
	Total	**141**	**100.0**	**65**	**100.0**
Level 2	1 hour – 5 hours	3	1.27	8	10.0
	5 hours – 9 hours	15	6.36	12	15.0
	9 hours – 13 hours	218	92.37	60	75.0
	Total	**236**	**100.0**	**80**	**100.0**
Basement Level	1 hour – 5 hours	7	5.6	7	10.1
	5 hours – 9 hours	17	13.6	11	16.0
	9 hours – 13 hours	101	80.8	51	73.9
	Total	**125**	**100.0**	**69**	**100.0**

In the case of multi-storey parking, the average parking duration at all three levels was more than 9 hours which again categorized as long term parking. However, the longest parking duration (10 hours and 43 minutes) was calculated to be at level 2 of the multi-storey parking. The average parking duration at surface parking area was lower than multi-storey parking (level 1, 2 and basement). It is also supported by the high turnover rate at surface parking (1.21 vehicles per space on weekday and 0.84 vehicles per space on weekend).

The average parking duration was shorter at all parking areas on weekend. It is due to that most of the users were traveled for trip purposes other than work trips on weekend. In the case of surface parking, the average parking duration on weekend was 6 hours 43 minutes. However, at the multi-storey parking, the average parking duration at all three levels was 9 hours and more which is classified as long-term parking. The parking at the basement level recorded the highest average parking duration (9 hours 17 minutes). Thus, it was found that

there exists a difference in the average parking duration between these two types of parking facilities on weekend. A high number of parking users parked their vehicles for a longer duration at the multi-storey parking because this parking facility was provided with a covered roof and also covered walkway to the transit building. On the other hand, some of the short-term parking users were parked their vehicles at the surface parking due to quick and easy accessibility to this parking facility from the main road.

5.4 Parking Turnover

The average parking turnover at the surface parking facility on weekday was 1.21 vehicles per space (table 4). The parking turnover at each of the parking facility is shown in table 3. When compared with different parking areas, the average parking turnover at the surface parking facility was the highest (4 vehicles per space). It is due to the attractiveness of this parking facility in terms of its location and accessibility. About 74% of the total parking spaces at this parking facility recorded a turnover of 1 vehicle per space. It means that less number of vehicle were left this parking area during the survey period indicating long parking duration.

Table 3. Parking turnover at Putrajaya Sentral park and ride facility

Parking Areas	Turnover rate (per space)	Weekday		Weekend	
		Number of parking space	Percentage (%)	Number of parking space	Percentage (%)
Surface Parking	4	1	0.8	0	0
	3	3	2.5	6	5.0
	2	22	18.2	14	11.6
	1	89	73.6	56	46.3
	0	6	5.0	45	37.2
	Total	**121**	**100.0**	**121**	**100.0**
Level 1	3	2	0.4	2	0.4
	2	7	1.5	2	0.4
	1	132	27.7	61	12.8
	0	335	70.4	411	86.3
	Total	**476**	**100.0**	**476**	**100.0**
Level 2	3	3	0.7	2	0.5
	2	13	3.2	10	2.4
	1	220	53.5	68	16.5
	0	175	42.6	331	80.5
	Total	**411**	**100.0**	**411**	**100.0**
Basement Level	3	0	0.0	1	0.2
	2	14	2.7	5	1.0
	1	111	21.6	63	12.3
	0	389	75.7	445	86.6
	Total	**514**	**100.0**	**514**	**100.0**

The average parking turnover at level 2 in the multi-storey parking facility was 0.62 vehicles per parking space which was higher than level 1 and basement parking. The highest turnover at individual parking spaces at level 2 was 3 vehicles per space. It is due to the attractiveness of this parking area in terms of its location which is nearer to the transportation terminal. The average parking turnover at Level 1 and basement parking was 0.33 and 0.27 vehicles per space respectively.

The weekend turnover has showed a similar pattern to that of weekday turnover where

the average parking turnover at the surface parking was higher (0.84 vehicles per space) than other parking areas. The highest turnover at individual parking spaces was 3 vehicles per space. However, the turnover was still lower on weekend than weekday because of the low parking demand. Generally, the average parking turnover at the multi-storey parking on weekend was low.

5.5 Parking Volume

The calculation of average parking volume showed that the parking volume on weekday was higher than weekend at all parking areas. The high utilization of parking spaces on weekday is again because of the users traveled for work and business purposes. On weekday, the surface parking was recorded an average parking volume of 204 vehicles per hour whereas among the three levels of parking in the multi-storey parking, level 2 has the highest average parking volume (407 vehicles per hour). Again, it is due to the location of this parking which is located at one level below the level accessing to the transit station. At Level 1 and basement level parking, the average parking volume was 237 and 207 vehicles per hour respectively. The differences in the average parking volume between surface parking and multi-storey parking (level 1, 2 and basement) are due to the differences in the number of parking spaces being provided at these parking facilities. The total number of parking spaces at multi-storey parking was much higher than the surface parking.

On weekend, the average parking volume at the surface parking was 100 vehicles per hour. This was less than half the parking volume on weekday. At multi-storey parking, level 2 again recorded high average parking volume, 126 vehicles per hour while at level 1 and basement level were 98 and 117 vehicles per hour respectively. It explains that the parking demand on weekend was lower than weekday.

Table 4. Summary of parking characteristics

Parking Characteristics	Weekday				Weekend			
	Surface	Level 1	Level 2	Basement	Surface	Level 1	Level 2	Basement
No. of Parking Spaces	121	476	411	514	121	476	411	514
No. of Vehicles Parked	146	157	255	139	102	71	94	76
Average Parking Occupancy (%)	84.5	24.9	49.7	19.6	41.7	9.9	15.1	10.4
Average Parking Volume (V ph)	204	237	407	207	100	98	126	117
Average Parking Turnover (V ps)	1.21	0.33	0.62	0.27	0.84	0.15	0.23	0.15
Average Parking Duration (hrs)	9 hrs 10 min	10 hrs 22 min	10 hrs 43 min	9 hrs 44 min	6 hrs 43 min	9 hrs	9 hrs	9 hrs 17 min

Note: Vph = Vehicle per hour; Vps = Vehicle per space; Hrs = Hour; min = minutes

6. DISCUSSION

The parking demand at each of the parking facility namely surface parking and multi-storey parking at Putrajaya public transportation park and ride terminal was different. Basically, the parking utilization pattern at the surface parking on weekday has high parking demand where

the parking occupancy rate was almost close to 100% at 9.00 am. Besides, vehicles parked illegally were noticed in this parking facility which obviously explains that the parking demand exceeds the parking supply at surface parking facility. The high demand at this parking facility can be compared with the parking facilities that are within the size of 100–300 spaces per station such as the stations in the north western part of Calgary which also achieved an average weekday utilization rate of between 80% and 100% (Abdul Hamid N., 2009). This parking pattern was also similar to that of parking demand at Shah Alam and Seremban park and ride stations, which showed high parking demand on weekdays. On the contrary, the parking occupancy at each level of the multi-storey parking facility showed low parking occupancy (below 30% on weekday and below 20% on weekend), indicating oversupply of parking spaces. The parking users at the multi-storey facility were satisfied on the provision of parking spaces as they found it easier to get empty parking space upon arrival at the multi-storey parking. During the survey, many empty parking spaces especially at level 1 and basement were seen. It is highly important to encourage more commuters to park at this facility and use public transportation for their various trip purposes especially work trips. This trend not only maximizes the use of multi-storey parking at this public transportation terminal but more importantly reduces the use of private vehicles entering into the city.

The accumulation pattern at all parking spaces showed similar pattern in which the accumulation curve at the surface parking has started to increase from 7.00 am to 9.00 am while in the multi-storey parking, it increases until 10.00 am. Then, the accumulation curve has started to decrease after 5.00 pm. This pattern is due to the commuters parking at these facilities early morning for work trips and leaving in the evening peak from work trips. This peak parking pattern in the early morning from 7:00 to 9:00 a.m. is similar to that of Tyne and Wear Metro park and ride stations (Pickett *et al.*, 1986).

The calculation of average parking duration at surface parking and multi-storey parking on weekday showed long-term parking with vehicles parked more than 9 hours. These findings are similar to that of Abdul Hamid N. (2009) for Seremban park and ride station, which showed about 82% of the park and ride users were long term users (more than 8 h). It is due to the spatial factor of the stations (Seremban and Putrajaya) which are located outside CBD and the travel pattern of the users who are mainly transit commuters.

On the contrary, on weekend, the average parking duration at all parking areas was generally shorter. It is because that the users who parked in these facilities on weekend were traveling for trips other than work trips. However, the parking duration between surface and multi-storey parking facility on weekend showed dissimilarities where the majority of users who parked at the surface parking belong to mid-term duration (5-8 hours) whereas at the multi-storey facility to long-term duration (more than 8 hours). The parking turnover at surface parking was 1.21 vehicles per space on weekday and 0.84 vehicles per space on weekend. In terms of the number of vehicles parked, obviously a high parking volume was calculated on weekday as compared to weekend.

7. CONCLUSIONS

The concept of the park and ride facility is a component of Travel Demand Management (TDM) strategy which can, eventually, increase the transit riderships. Generally, the increase in the utilization of the park and ride facility would increase public transport riderships. Hence, it is essential to evaluate the demand for park and ride facility in order to know the current usage of such facility as well as the travel pattern of the parking users. The findings

showed that the park and ride facilities at Putrajaya public transport terminal namely "Putrajaya Sentral" has not reached to its maximum utilization rate. The parking demand at the two types of parking areas at the park and ride facility showed different parking occupancy. The parking demand at the surface parking was generally high as it was found that the parking spaces were fully occupied as early as 9.00 am reaching the highest occupancy rate of 95% on weekday. When compared with surface parking, the multi-storey parking showed lower parking occupancy, reaching not more than 50%. However, the parking demand at this facility was higher on weekday than weekend because of the users who parked at this facility were traveled for work and business purposes. The parking facility has recorded a parking duration of more than 9 hours. The parking demand at the multi-storey parking facility has revealed that the number of users who parked at this facility was lower than surface parking. Adequate measures should be taken to maximize the use of park and ride facility and in this case, the multi-storey parking to encourage commuters to shift from using private transport to public transport. Evidently, it will help to decrease the number of vehicles entering into the cities thereby achieving the universal goal and benefits of sustainable transportation.

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